

SECTION I.—AEROLOGY.

FREE-AIR DATA IN SOUTHERN CALIFORNIA, JULY AND AUGUST, 1913.

By the Aerial Section—WM. R. BLAIR in Charge.

[Dated, Mount Weather, Va., May 26, 1914.]

The Astrophysical Observatory, of the Smithsonian Institution, and the Mount Weather Observatory of the Weather Bureau cooperating during July and August, 1913, made observations in southern California: (a) Of solar radiation at high levels, by means of a photographically recording pyr heliometer, carried by free balloons; (b) of the total moisture content of the air above Mount Wilson, by means of the spectroscopic; (c) of nocturnal radiation, by means of the K. Ångström compensation apparatus; (d) of the meteorological elements, air pressure, temperature, humidity and movement, at different altitudes by means of meteorographs, carried by free balloons at Avalon, and by captive balloons at Lone Pine and at the summit of Mount Whitney. The pyr heliometric observations have already been discussed by C. G. Abbot in Science, March 6, 1914. It is the purpose of this present paper to communicate more particularly the meteorological observations.

(a) THE FREE BALLOON OBSERVATIONS.

Morning and evening ascensions were made on July 23 and 24, 1914, and thereafter daily ascensions until August 12, 1914—23 ascensions in all. When a pyr heliometer was taken up, in addition to the meteorograph, the ascension for the day was so timed that the highest point would be reached about noon. On other days the ascensions were made shortly after sunrise or just before sunset. Table 1 shows the number of balloons recovered, their landing points; and other information of general interest.

TABLE 1.—Statistics of sounding balloon flights from Avalon, Cal., during July and August, 1913.

Date.	Hour.	Balloons.		Landing point.	Horizontal distance traveled.	Direction traveled.	Highest altitude reached.	Lowest temperature recorded.
		Number.	Ascensional force.					
1913			Kp.		Km.		M.	°C.
July 23	6:06 a....	2	.....	Huntington Beach, Cal.	42	ne.	25,160	-56.0
24	5:13 p....	2	0.8	Armada, Cal.	122	ene.	20,389	-55.8
26	5:11 p....	2	0.8	San Diego, Cal.	131	ese.		
27	4:57 p....	2	0.9	Oceanside, Cal.	91	e.	23,870	-64.7
28	5:05 p....	2	1.1	Chino, Cal.	97	ne.	19,485	-62.6
29	11:10 a....	2	1.2	Los Angeles, Cal.	80	n.	23,066	-60.4
30	10:54 a....	2	1.0	Atmore's Ranch, Cal.	140	nnw.	32,643	-53.9
Aug. 31	10:37 a....	2	1.6	Los Pasos Hills, Cal.	122	nnw.	22,394	-58.9
1	10:36 a....	2	1.4	New Hall, Cal.	128	n.	23,486	-58.6
2	10:59 a....	2	1.3	Inglewood, Cal.	72	n.	21,302	-67.3
3	5:07 p....	2	0.9	Downey, Cal.	70	n.	17,428	-67.5
5	5:07 p....	2	0.8	Fullerton, Cal.	75	nne.		
7	4:52 p....	2	0.8	Colton, Cal.	120	ne.	6,442	-25.2
8	5:23 p....	2	0.9	Baldwin Park, Cal.	97	nne.	14,100	-43.9
10	4:43 p....	2	0.9	Pacific Ocean.	4	nw.	1,976	19.3

All free balloons were started at Avalon, Santa Catalina Island, Cal. Because of the possibility of the instrument coming down in the ocean, balloons were sent up in pairs and with a float. This float weighed approximately 450 grams. Each balloon was filled until it would lift decidedly everything to be sent up except the float. The balloons were then attached to the system in such a way that when either of them burst it would detach itself from the system, which then sank to the earth's surface

with the remaining balloon. This device by which the balloons are connected with the system and which serves the purpose of releasing the burst balloon is shown in figure 1. It is made of spring brass wire of approximately 2.4 mm. diameter. The pressure of the springs B and C on the wire A at the points D and E is sufficient to prevent the rings from slipping off in case cord F or G becomes slack. The weight of the burst balloon or of what is left of it slips the ring off easily. Cords F and G must be so short that they will not twist above the device.

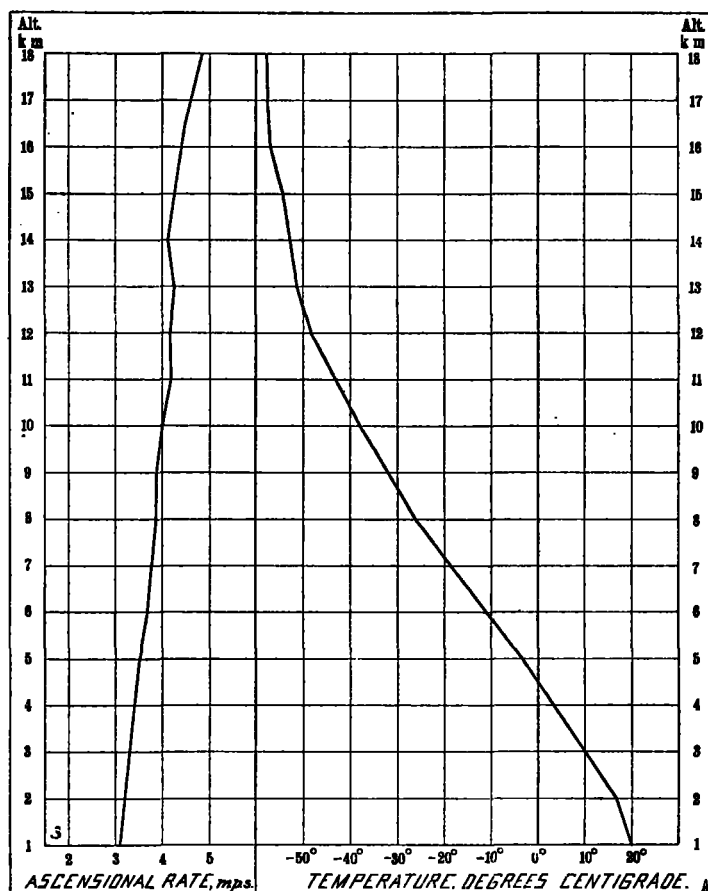


FIG. 3.—Relation between ascensional rates of balloons and air temperatures.

The balloons used were of thick rubber, similar to those used at Huron in the early autumn of 1910 and at Fort Omaha in the late winter of 1911 but not so large. They were filled with electrolytic hydrogen which had been compressed in steel cylinders.

The highest ascension of the series was made on July 30. This exceeds the previous highest ascension from this continent by more than two kilometers. The record obtained in this ascension is shown in figure 2.

In seven of the ascensions from which records were returned the instrument was carried to an altitude of 18 or more kilometers above sea level. The temperatures recorded and the ascensional rates of the balloons have been averaged and compared in Table 2 and in figure 3.

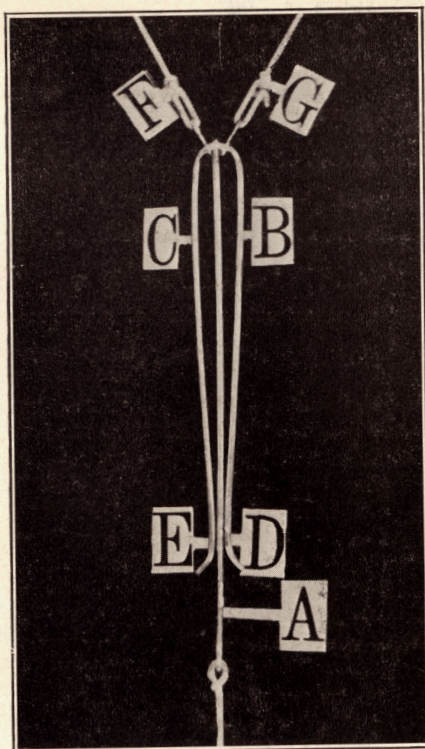


FIG. 1.—Device for releasing burst balloon.

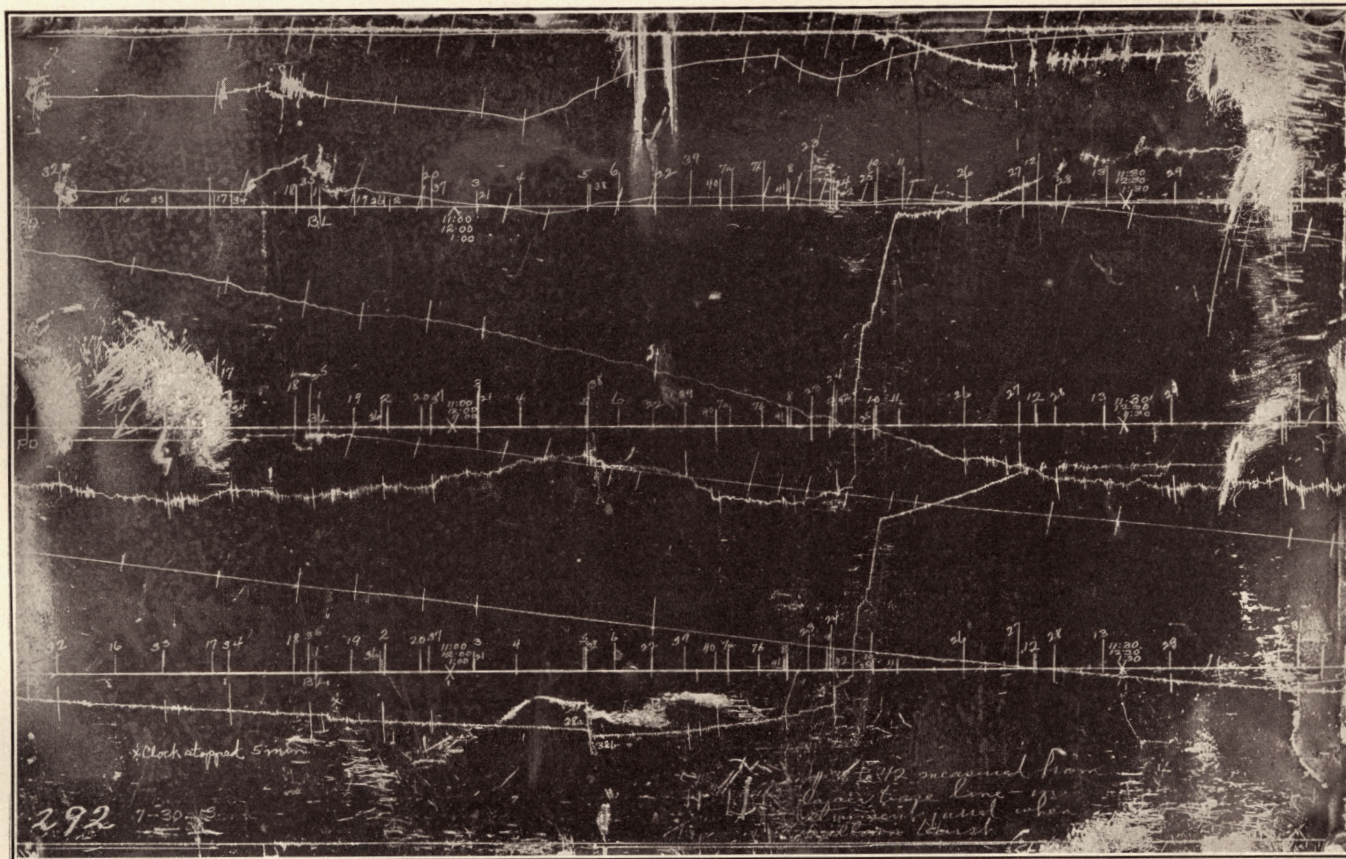


FIG. 2.—Record obtained in sounding balloon ascension of July 30, 1913.

TABLE 2.—Temperatures recorded at different altitudes and ascensional rates of balloons for sounding balloon ascensions at Avalon, Cal., July and August, 1913.

Altitude above surface.	July 23.		July 24.		July 27.		July 30.		July 31.		Aug. 1.		Aug. 3.		Means.		Altitude above surface.
	Rate of ascent.	Temperature.	Rate of ascent.	Temperature.	Rate of ascent.	Temperature.	Rate of ascent.	Temperature.	Rate of ascent.	Temperature.	Rate of ascent.	Temperature.	Rate of ascent.	Temperature.	Rate of ascent.	Temperature.	
Km.	M. p. s.	°C.	M. p. s.	°C.	M. p. s.	°C.	M. p. s.	°C.	M. p. s.	°C.	M. p. s.	°C.	M. p. s.	°C.	M. p. s.	°C.	Km.
1.	4.02	18.5	3.14	14.6	3.33	13.3	1.58	18.2	3.97	21.6	2.78	24.2	2.90	30.0	3.10	20.1	1
2.	4.17	12.6	3.33	14.7	3.27	9.6	1.55	20.3	4.17	18.7	2.90	18.3	3.03	21.8	3.20	16.6	2
3.	4.44	5.5	3.51	8.1	3.27	2.5	1.63	18.5	4.27	12.8	3.03	10.9	3.06	14.6	3.32	10.4	3
4.	4.63	-1.0	3.53	2.4	3.27	-4.7	1.81	11.0	4.33	5.8	3.17	3.0	3.09	7.3	3.41	3.5	4
5.	4.76	-7.9	3.51	-2.8	3.33	-13.3	2.12	3.8	4.44	-1.5	3.40	-1.6	3.09	-0.5	3.52	-3.4	5
6.	4.90	-14.7	3.51	-9.3	3.44	-20.5	2.42	-3.5	4.76	-11.3	3.51	-9.5	3.21	-8.2	3.68	-11.0	6
7.	4.90	-21.6	3.51	-16.3	3.40	-29.0	2.67	-9.8	5.21	-20.6	3.62	-17.5	3.27	-17.0	3.80	-18.8	7
8.	4.90	-29.1	3.33	-20.8	3.40	-38.4	2.92	-15.9	5.46	-28.6	3.79	-23.5	3.27	-24.5	3.87	-25.8	8
9.	4.83	-34.3	3.21	-26.3	3.40	-45.1	3.12	-22.3	5.65	-34.6	3.92	-30.0	3.12	-31.1	3.89	-32.0	9
10.	4.90	-38.8	3.12	-31.7	3.33	-50.2	3.44	-30.2	5.95	-42.2	4.12	-36.6	3.14	-36.8	4.00	-38.1	10
11.	5.56	-41.4	2.95	-38.2	3.30	-53.8	3.70	-37.3	6.41	-47.4	4.12	-43.2	3.33	-42.7	4.20	-43.4	11
12.	5.13	-43.4	2.95	-42.4	3.37	-57.4	3.83	-44.2	6.41	-52.3	4.12	-49.4	3.33	-49.2	4.16	-48.3	12
13.	5.56	-46.5	3.06	-45.5	3.37	-57.5	3.88	-49.1	6.54	-56.9	4.17	-52.3	3.37	-50.1	4.28	-51.1	13
14.	4.07	-50.6	3.21	-46.6	3.44	-58.7	4.02	-51.3	6.67	-56.7	4.12	-49.8	3.37	-54.0	4.13	-52.5	14
15.	4.17	-54.8	3.37	-49.6	3.88	-61.5	4.33	-49.2	6.67	-55.4	4.12	-50.5	3.37	-50.2	4.27	-54.3	15
16.	4.63	-55.8	3.55	-52.2	4.57	-62.2	4.57	-50.3	6.80	-57.7	3.88	-54.0	3.33	-65.3	4.46	-66.8	16
17.	5.38	-56.6	3.74	-55.4	3.70	-63.0	4.90	-49.8	6.94	-58.6	4.22	-56.0	3.51	-62.3	4.63	-57.4	17
18.	6.29	-56.7	3.38	-55.6	3.47	-60.8	5.13	-53.0	7.58	-58.0	4.83	-58.0	3.51	-62.0	4.88	-57.7	18

The mean of the observed temperatures in the seven ascensions does not show a minimum of temperature below the 18-kilometer level. The mean of the ascensional rates of the balloons shows, in general, an increase with altitude. Above the 18-kilometer level the individual ascensions show a decrease in the ascensional rates of the balloons soon after the minimum of temperature has been passed through. This relation between the air temperature and the ascensional rate of the balloons is similar to that already found. (See Bull. Mount Weather Observatory, Washington, 1911, 4: 186.) It indicates that, in addition to the known factors entering into the ascensional rate of any balloon, there is the unknown factor of the difference in temperature between the gas in the balloon and the air through which the balloon is passing. While the temperature distribution in the free air is in general known, it would be impossible to predict, with sufficient accuracy for a particular ascension, the point of maximum ascensional rate or minor variations in the rate. On the other hand, careful observation of the ascensional rate of a free, sealed, rubber balloon might indicate fairly well the peculiarities of the temperature distribution at the time of the ascension. In this connection the author calls attention to an entirely erroneous statement in Bulletin of the Mount Weather Observatory, 4:186, regarding the adiabatic cooling of hydrogen gas. The approximate rate of cooling per kilometer came in some way to be considered the rate to the 15-kilometer level. The statement based on this error should not have appeared, nor is it needed to account for the observed peculiarities in the ascensional rate of free rubber balloons under consideration.

The instruments used were the same as those used in previous series of soundings. The calibration of the instruments was similar to that for previous series, except that the pressure and temperature elements were calibrated in a smaller chamber in which ventilation and temperature were under somewhat better control and in which temperatures down to $-60^{\circ}\text{C}.$ could easily be obtained. (See Bulletin Mount Weather Observatory, Washington, 1911, 4:187.)

The data obtained in each ascension are presented in Table 4 with interpolations at the 500-meter intervals up to 5 kilometers above sea level, and at 1-kilometer intervals above the 5-kilometer level. In figure 4 a diagram of the temperature-altitude relation is shown for each observation. Figure 5 shows the mean value of this relation for the period. The free air isotherms for the period are

shown in figure 6. The horizontal projections of the balloon paths, as far as they could be observed, are shown in figure 7. Only one theodolite was used, the altitudes being computed from the observed air pressures.

An inversion of temperature, with the maximum temperature somewhere between the $\frac{1}{2}$ - and 2-kilometer levels, is shown in each curve of figure 4. This inversion of temperature is found, whether the observation be made in the morning, near noon, or in the late afternoon. It does not seem to accompany any particular wind direction. A similar inversion of temperature was observed in most of the ascensions made at Indianapolis, Fort Omaha, and Huron.

As shown in figure 5, the altitude at which the mean temperature for the period is a minimum is 17 kilometers. The minimum temperature observed in any ascension may be more than a kilometer above or below the height of this mean. In two ascensions, those of the 23d and 27th of July, the change of temperature with altitude begins to decrease at about the 8-kilometer level, while in the ascensions of August 2 and 3 this change does not take place until the 12-kilometer level. The temperature change from day to day is best shown in figure 6. The lowest temperature observed, $-67.5^{\circ}\text{C}.$, was at about the 16.5 kilometer level on August 3. About the same temperature had been observed at the 16-kilometer level on the day before.

A comparison of the curve shown in figure 5 with that shown in the Bulletin of the Mount Weather Observatory, 4: 302, figure 31, shows the surface temperature indicated in figure 5 higher by $6.4^{\circ}\text{C}.$, the minimum temperature lower by $3.5^{\circ}\text{C}.$, the maximum next above this minimum less than $2^{\circ}\text{C}.$ lower than the corresponding values shown in figure 31. The minimum temperature shown in figure 5 occurs at an altitude higher by 1.5 kilometers than that shown in figure 31. The maximum temperature next above the minimum temperature is shown at about the same altitude in both curves. The curves have the same general appearance. That shown in figure 5 represents summer conditions at latitude $33^{\circ}\text{N}.$ That shown in figure 31 represents conditions in all seasons, to some extent; the late summer and early autumn being better represented than the other seasons, at about latitude $40^{\circ}\text{N}.$

The variations of humidity with altitude and from day to day are rather closely related to the variations of temperature. In Table 3 the absolute humidities observed have been assembled and a mean shown.

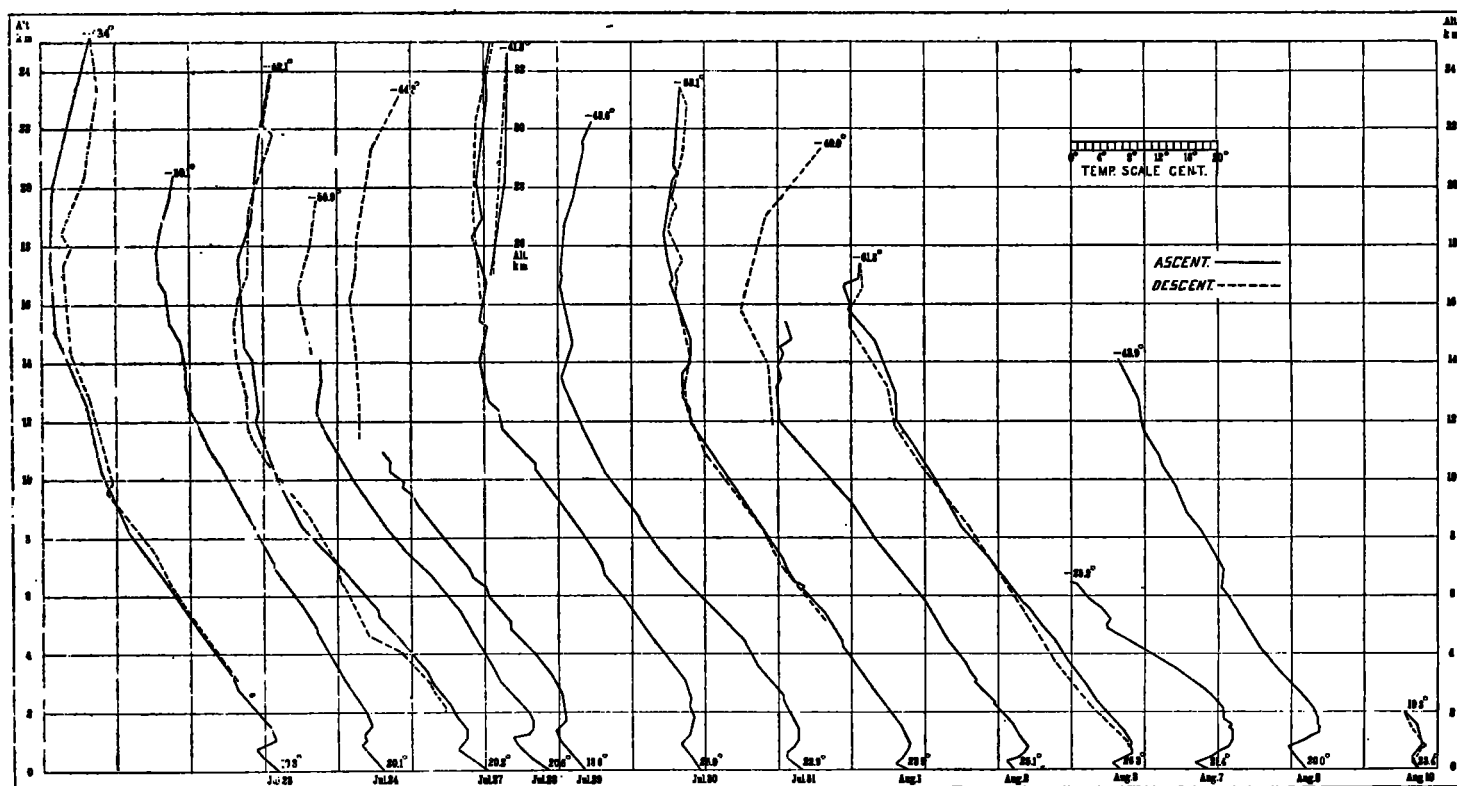


FIG. 4.—Vertical temperature gradients at Avalon, Cal., July 23-August 10, 1913.

TABLE 3.—Absolute humidity (grams per cubic meter) at various levels on different dates, Avalon, Cal., 1913.

Date.		Altitude (meters).																		
		34	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000.	6,000.	7,000.	8,000.	9,000.	10,000.	11,000.	12,000.	13,000.
1913.																				
July	23	12.651	10.109	9.248	6.942	5.597	4.495	3.354	2.291	1.608	1.106	0.793	0.415	0.207	0.095	0.055	0.034	0.024	0.019	0.013
	24	11.363	9.740	8.808	7.562	6.493	5.371	2.976	2.329	1.820	1.441	1.162						0.035	0.023	0.016
27		11.949	9.687	8.708	7.288	5.003	2.852	1.661	1.301	1.064	0.839	0.581	0.289	0.118	0.040	0.017	0.009	0.006	0.003	0.003
	28	10.813	8.755	7.980	5.330	3.642	2.985	2.429	1.480	1.015	0.698	0.516	0.272	0.125	0.051	0.023	0.010	0.005	0.003	0.003
29		9.993	9.372	8.913	7.645	4.711	3.056	1.964	1.163	0.674	0.384	0.265	0.112	0.060	0.019	0.011	0.006	0.002		
	30	12.415	11.913	10.625	6.418	5.922	4.108	2.351	1.381	0.993	0.780	0.687	0.330	0.219	0.103	0.048	0.020	0.010	0.004	0.003
Aug.	31	12.352	11.261	8.640	4.717	2.379	1.434	1.444	1.210	0.855	0.580	0.344	0.193	0.118	0.062	0.034	0.014	0.007	0.004	0.002
	1	15.210	12.077	9.369	8.072	6.661	5.459	4.730	4.268	3.367	2.302	1.662	0.831	0.406	0.199	0.103	0.054	0.026	0.013	0.009
2		15.817	13.926	7.750	5.828	5.657	5.255	3.986	2.781	1.840	1.243	0.922	0.476	0.235	0.105	0.055	0.021	0.008	0.003	0.003
	3	15.199	12.014	4.205	2.925	2.850	2.541	2.109	1.560	1.178	0.898									
7		14.482	13.779	6.274	2.631	1.521	1.256	1.353	1.300	1.065	1.299	1.362	0.432							
	8	12.523	11.342	11.336	9.476	7.983	6.572	5.055	3.961	3.278	2.806	2.368	1.623	1.180	0.655	0.346	0.215	0.124	0.077	0.055
10		12.977	9.937	4.654	3.106	2.421														
	Means	12.900	11.036	8.193	5.995	4.565	3.657	2.785	2.085	1.563	1.198	0.969	0.497	0.296	0.148	0.077	0.043	0.025	0.017	0.012

Date.		Altitude (meters).																		
		14,000	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	26,000	27,000	28,000	29,000	30,000	31,000	32,000
1913.																				
July	23	0.006	0.004	0.004	0.003	0.003	0.004	0.004	0.006	0.007	0.010	0.014	0.018							
	24	0.013	0.010	0.007	0.004	0.004	0.006	0.008	0.008	0.004	0.005	0.007								
27		0.003	0.002	0.001	0.001	0.002	0.003	0.003	0.003	0.004	0.005	0.007								
	28	0.003	0.001	0.001	0.001	0.002	0.002													
30		0.002	0.003	0.002	0.002	0.002	0.002	0.001	0.002	0.002	0.002	0.002	0.003	0.004	0.004	0.005	0.005	0.005	0.006	0.006
	31	0.002	0.003	0.002	0.001	0.002	0.002	0.003	0.004	0.005										
Aug.	1	0.012	0.011	0.007	0.005	0.004	0.004	0.006	0.006	0.007	0.008									
	2	0.003	0.004																	
8		0.033																		
	Means	0.009	0.005	0.003	0.002	0.003	0.003	0.004	0.004	0.005	0.006	0.008	0.010	0.004	0.004	0.005	0.005	0.005	0.006	0.006

The distribution of pressure at the earth's surface changes but little in type, and that never abruptly, during the period of observation nor does the pressure itself vary much from day to day. Figures 7 and 8 show the pressure distribution in a general way for the whole

period. The positions of the centers of high and low pressure at 8 a. m. or 8 p. m., seventy-fifth meridian time, are shown by the circles, in which dates are also indicated. In the case of high pressure, these circles are connected by solid lines; in the case of low pressure, by dashed lines.

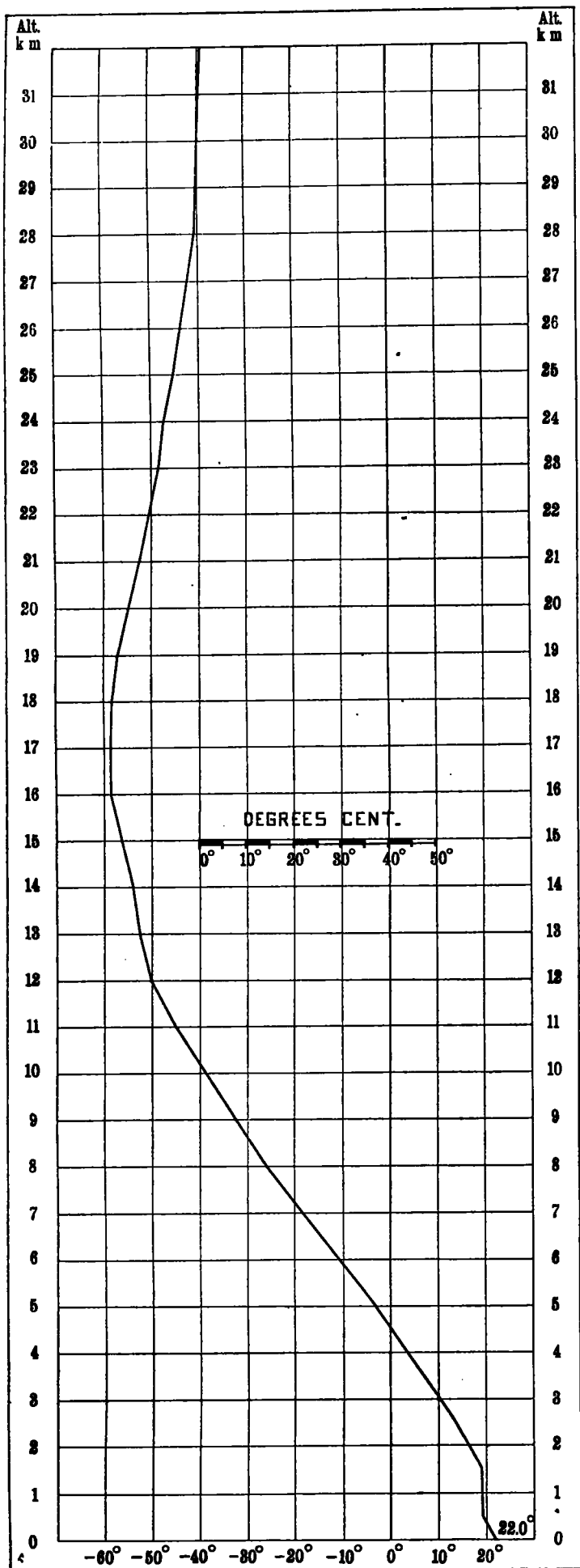


FIG. 5.—Curve showing mean temperature gradient at Avalon, Cal., July 23–August 3, 1913.

In three of the ascensions July 24 and 27 and August 3, the balloons were followed with the theodolite beyond the altitude at which the minimum temperature was recorded (see fig. 9). In another, August 2, the air movement could be observed up to 17 kilometers. On July 24 and 27 the winds were westerly, with a small south component up to the height at which the minimum temperature was found. Above this height the wind was easterly. On August 2 and 3 the winds were southerly, with a small west component up to the point of minimum temperature. Here again the winds became easterly. On July 24 the wind velocity increased as the easterly component made its appearance; on July 27 there was little change; on August 2 and 3 there was a decided decrease in velocity as the wind became easterly.

TABLE 4.—Results of sounding balloon ascensions, Avalon, Cal.

JULY 23, 1913.

Time.	Altitude.	Pressure.	Temperature.	Δt 100 m.	Humidity.		Wind.		Remarks.
					Rel.	Abs.	Direction.	Vel.	
A. M.	M.	Mm.	° C.		P. d.	g/m ³		M.p.s.	
6 08.0	34	759.5	19.3		77	12.51			10/10 S. NNW.
6 08.0	489	719.8	14.3	1.1	83	10.111	N. 48° W.	1.1	
6 09.1	500		14.1		84	10.109	N. 47° W.	1.1	
6 09.1	737	699.0	12.4	0.8	92	9.972	N. 17° W.	1.0	In base of clouds. Inversion.
6 10.2	1,000		18.5		59	9.248			
6 12.2	1,032	675.0	18.9	-2.2	57	9.147			
6 12.2	1,454	642.3	17.1	0.4	49	7.068			
6 17.4	1,500		16.8		49	6.942			
6 17.4	2,000		12.6		51	5.567			
6 17.4	2,500		8.5		53	4.495			
6 17.4	2,784	547.5	6.3	0.8	54	3.975			
6 18.9	3,000		5.5		48	3.351			
6 18.9	3,194	520.8	4.9	0.3	43	2.888			
6 18.9	3,500		2.5		40	2.291			
6 24.6	4,000		1.0		36	1.608			
6 24.6	4,500		-4.6		33	1.108			
6 24.6	4,719	430.1	-6.1	0.7	31	0.919			
6 24.6	4,818	424.7	-6.6	0.5	31	0.882			
6 31.7	5,000		-7.9		31	0.793			
6 31.7	5,000		-14.7		29	0.415			
6 31.7	6,783	327.9	-20.0	0.7	27	0.241			
6 36.4	7,000		-21.6		27	0.207			
6 36.4	8,000		-29.1		25	0.095			
6 36.4	8,184	271.4	-30.5	0.8	25	0.082			
6 42.9	8,000		-34.3		25	0.055			
6 42.9	10,000		-38.8		25	0.034			
6 42.9	10,289	200.9	-39.9	0.4	25	0.030			
6 50.4	11,000		-41.4		24	0.021			
6 50.4	12,000		-42.4		23	0.019			
6 50.4	12,584	143.9	-44.6	0.2	22	0.016			
6 50.4	13,000		-45.5		22	0.013			
6 50.4	14,000		-50.6		20	0.008			
6 50.4	15,000		-54.8		20	0.004			
6 50.4	15,022	98.6	-55.2	0.2	20	0.004			
6 50.4	16,000		-55.8		20	0.003			
6 50.4	17,000		-56.6		20	0.003			
6 50.4	17,379	69.2	-56.9	0.1	20	0.003			Inversion
6 50.4	18,000		-56.7		20	0.003			
6 50.4	19,000		-56.4		21	0.004			
6 50.4	19,983	46.1	-56.1	0.0	21	0.004			
6 50.4	20,000		-56.1		21	0.004			
6 50.4	21,000		-53.6		22	0.006			
6 50.4	22,000		-51.2		22	0.007			
6 50.4	23,000		-48.7		22	0.010			
6 50.4	24,000		-46.3		23	0.014			
6 50.4	25,000		-43.8		23	0.018			
6 50.4	25,180	21.5	-43.4	-0.1	23	0.019			
6 50.4	26,000		-43.0		23	0.020			
6 50.4	27,000		-42.1		21	0.020			
6 50.4	28,000		-41.2		20	0.021			
6 50.4	29,000		-41.2		19	0.021			
6 50.4	30,000		-42.6		19	0.017			
6 50.4	31,000		-44.2		18	0.013			
6 50.4	32,000		-45.1		17	0.011			
6 50.4	33,000		-46.4		17	0.009			
6 50.4	34,000		-50.5		17	0.005			Inversion.
6 50.4	35,000		-52.8	0.5	18	0.006			
6 50.4	36,000		-50.7		18	0.007			
6 50.4	37,000		-50.0	-0.3	18	0.007			Inversion.
6 50.4	38,000		-52.1	0.1	18	0.006			
6 50.4	39,000		-51.3		19	0.006			
6 50.4	40,000		-51.1		19	0.007			
6 50.4	41,000		-50.4		20	0.008			
6 50.4	42,000		-49.8	0.4	20	0.008			
6 50.4	43,000		-48.6		21	0.015			
6 50.4	44,000		-44.5		21	0.018			
6 50.4	45,000		-43.0	3.3	21	0.021			
6 50.4	46,000		-41.5		22	0.030			
6 50.4	47,000		-38.8		23	0.041			
6 50.4	48,000		-36.4		23	0.042			
6 50.4	49,000		-36.0	-0.5	24	0.035			Inversion.
6 50.4	50,000		-37.7	3.8	25	0.055			
6 50.4	51,000		-33.5		25	0.071			
6 50.4	52,000		-31.0	0.8	25	0.129			
6 50.4	53,000		-25.8		27	0.207			
6 50.4	54,000		-21.6	0.5	28	0.265			
6 50.4	55,000		-19.4		29	0.350			
6 50.4	56,000		-16.4	0.6	30	0.464			
6 50.4	57,000		-13.8		32	0.832			
6 50.4	58,000		-7.7	0.7	32	0.832			
6 50.4	59,000		-7.4		32	1.126			
6 50.4	60,000		-4.0		32	1.464			
6 50.4	61,000		-0.7		32	1.612			
6 50.4	62,000		0.6		32				

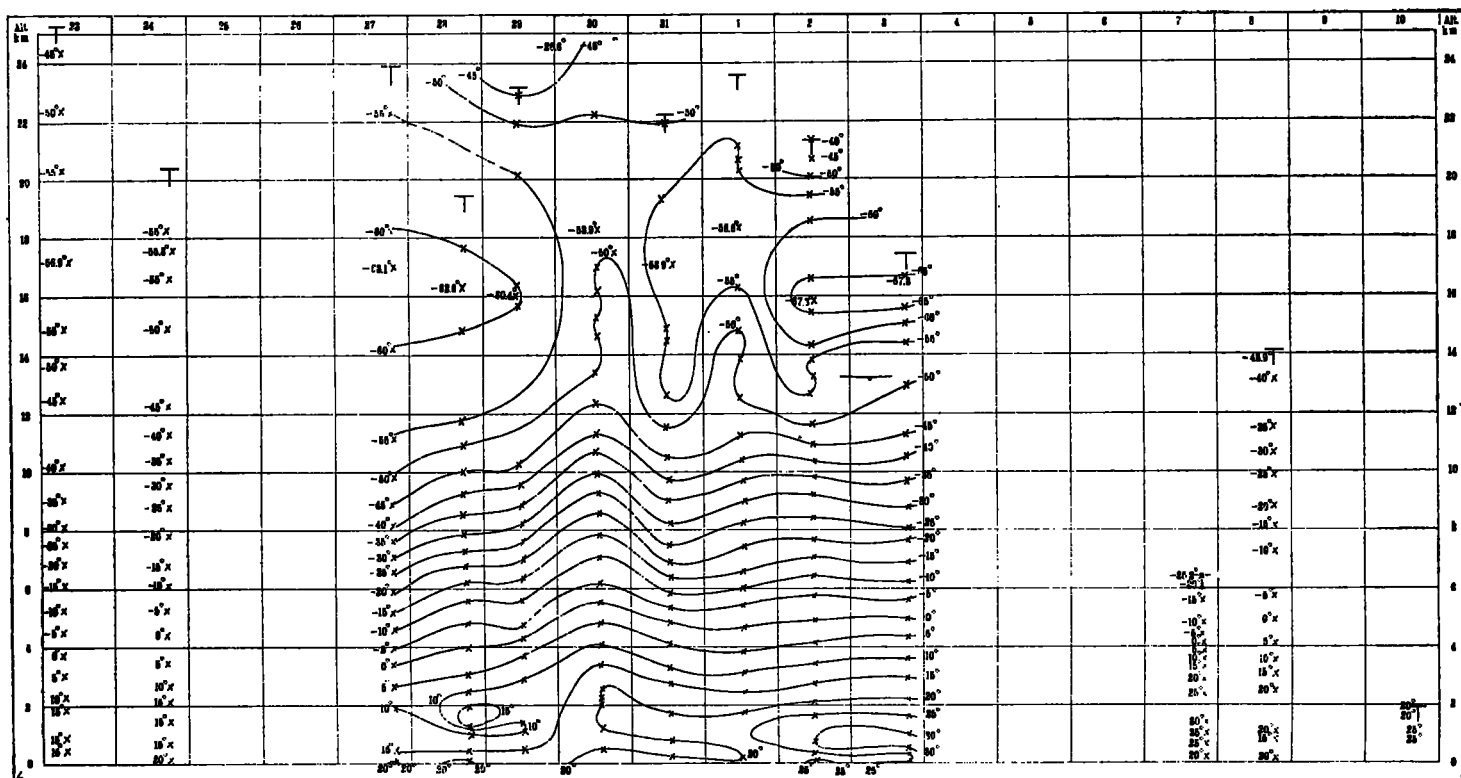


FIG. 6.—Free-air temperatures at Avalon, Cal., July 23-August 10, 1913.

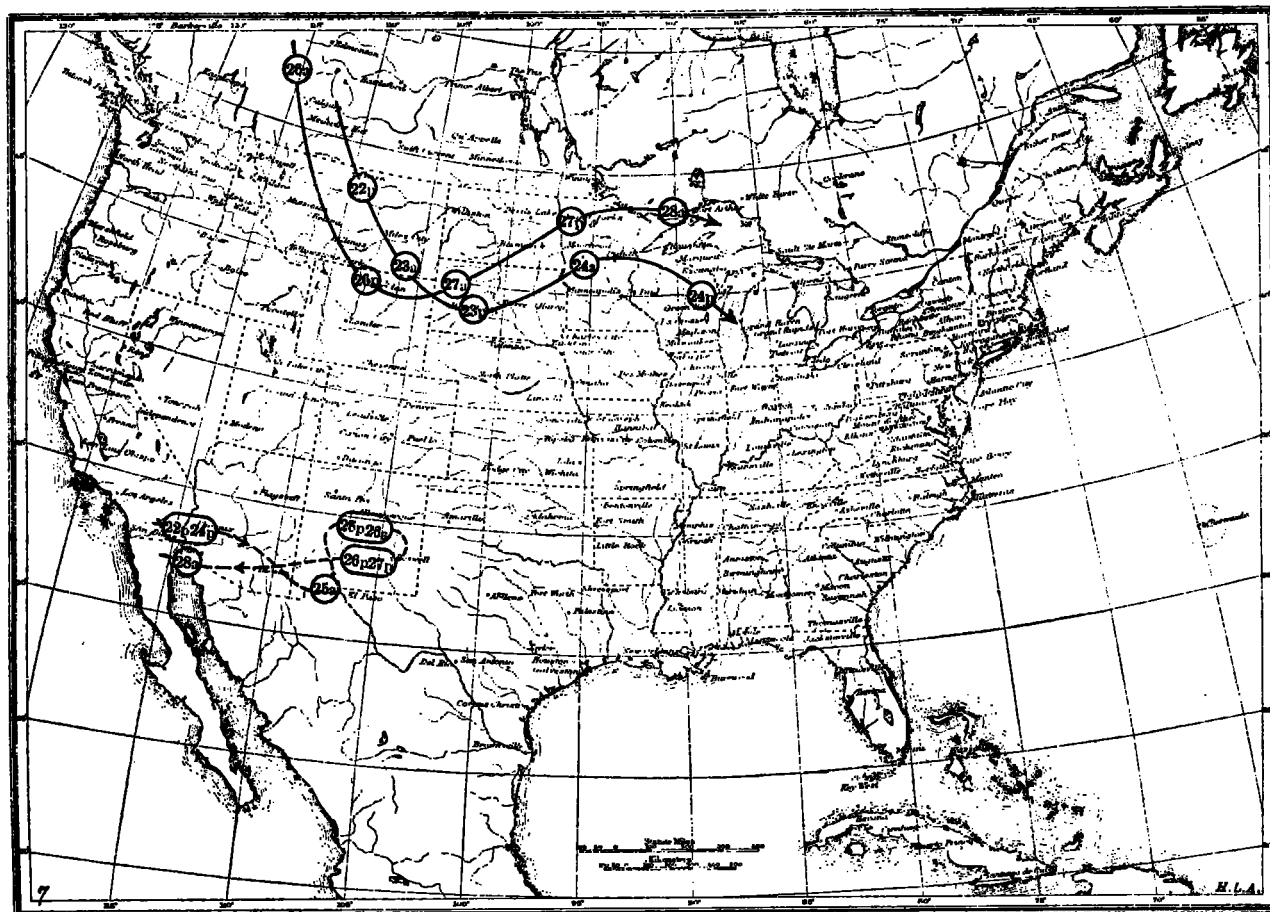


FIG. 7.—Pressure distribution in the western United States, July 22-23, 1913.

TABLE 4.—Results of sounding balloon ascensions, Avalon, Cal.—
Continued.

JULY 24, 1913.

Time.	Altitude.	Pressure.	Temperature.	At 100 m.	Humidity.		Wind.		Remarks.
					Rel.	Abs.	Direction.	Vel.	
A. M.	M.	Mm.	° C.		P. ct.	g./m ³ .	SW.	M.p.s.	
5 13.8	34	759.7	20.1	0.9	66	11.363	S. 26° W.	5.9	
5 15.0	290	737.3	17.7	0.8	69	10.315	S. 49° W.	5.9	Few S. Cu. SW.
	500		15.8		73	9.740	S. 49° W.	4.8	
5 18.1	858	689.3	13.0	0.8	79	8.887	N. 83° W.	3.1	Inversion.
	1,000		14.0		71	8.808	S. 68° W.	2.5	
5 18.8	1,005	677.4	14.0	-1.1	70	8.684	S. 67° W.	2.4	
5 20.1	1,220	660.3	13.7	0.4	63	7.398	S. 76° W.	1.3	Inversion.
	1,500		10.3		55	7.562	S. 31° W.	6.2	
5 21.3	1,507	638.1	10.4	-0.9	58	7.608	S. 30° W.	6.4	
5 23.9	1,925	607.5	15.1	0.8	41	6.243	S. 29° W.	7.6	
	2,000		14.7		40	4.993	S. 29° W.	8.0	
	2,500		11.4		38	3.871	S. 25° W.	10.0	
5 29.0	2,984	534.9	8.3	0.6	36	3.015	S. 22° W.	11.9	
	3,000		8.1		36	2.976	S. 22° W.	12.0	
	3,500		5.2		34	2.329	S. 37° W.	12.8	
5 33.5	3,907	477.8	2.8	0.6	32	1.870	S. 49° W.	13.4	
	4,000		2.4		32	1.820	S. 49° W.	13.6	
	4,500		0.5		31	1.441	S. 48° W.	14.3	
5 37.8	4,759	429.8	-1.9	0.6	30	1.249	S. 48° W.	14.7	
5 38.3	4,853	424.7	-1.9	0.0	30	1.249	S. 41° W.	21.7	
	5,000		-2.8		30	1.162	S. 44° W.	21.2	
5 42.1	5,588	386.9	-6.2	0.6	29	0.852	S. 58° W.	18.9	
	6,000		-8.3				S. 58° W.	18.2	
5 48.2	6,988	323.4	-16.3	0.7			S. 58° W.	16.7	
	7,000		-16.3				S. 60° W.	13.6	
5 48.8	7,114	317.0	-16.3	0.0			S. 66° W.	4.0	
5 53.1	7,989	281.8	-20.8	0.5			S. 62° W.	25.3	
	8,000		-20.8				S. 62° W.	25.3	
	8,000		-26.3				S. 63° W.	24.2	
5 58.5	9,171	240.2	-27.3	0.6			S. 63° W.	24.0	
	10,000		-31.7				S. 72° W.	24.4	
6 06.2	10,423	201.6	-34.7	0.5			S. 77° W.	24.6	
	11,000		-38.2		24	0.035	S. 72° W.	23.6	
6 08.9	11,016	185.3	-38.3	0.7	24	0.034	S. 72° W.	23.5	Few S. Cu. SW.
6 15.1	11,894	163.5	-41.8	0.4	25	0.024	S. 70° W.	19.2	
	12,000		-42.4		25	0.023	S. 73° W.	18.7	
6 18.3	12,464	150.3	-45.1	0.6	24	0.016	S. 84° W.	16.4	
6 20.0	12,902	140.7	-45.1	0.0	24	0.016	S. 63° W.	22.2	
	13,000		-45.5		24	0.016	S. 63° W.	20.4	
6 21.6	13,206	134.5	-46.1	0.3	24	0.014	S. 63° W.	16.1	
6 24.0	13,711	124.9	-46.0	0.0	23	0.014	S. 63° W.	18.2	
	14,000		-46.6		23	0.013	S. 59° W.	18.4	
6 28.7	14,716	107.6	-47.9	0.2	23	0.012	S. 47° W.	18.8	
	15,000		-49.6		23	0.010	S. 54° W.	15.7	
6 32.8	15,297	98.5	-51.3	0.6	23	0.008	S. 61° W.	12.3	
	16,000		-52.2		23	0.007	S. 48° W.	13.2	
6 36.6	16,453	82.3	-52.8	0.1	23	0.006	S. 39° W.	13.9	
6 38.7	16,795	78.3	-55.1	0.7	22	0.005	S. 67° W.	1.7	
	17,000		-55.4		22	0.004	S. 40° W.	3.2	
6 42.4	17,763	67.6	-55.8	0.1	22	0.004	S. 22° E.	9.0	Inversion.
	18,000		-55.6		22	0.004	S. 74° E.	6.3	
6 45.2	18,207	63.1	-55.1	-0.1	22	0.005	N. 60° E.	4.3	Few S. Cu. SW.
6 48.0	18,511	60.2	-54.8	-0.1	23	0.005	S. 85° E.	13.9	
	19,000		-53.2		23	0.006	S. 75° E.	10.1	
6 53.3	19,619	50.8	-51.4	-0.3	24	0.009	S. 63° E.	5.3	
	20,000		-50.8		24	0.008	S. 4° E.	4.4	
6 57.0	20,389	45.1	-50.1	-0.2	24	0.009	S. 57° W.	3.4	Balloons disappeared.

TABLE 4.—Results of sounding balloon ascensions, Avalon, Cal.—Continued.

JULY 27, 1913--Continued.

Time.	Altitude.	Pressure.	Temperature.	At 100 m.	Humidity.		Wind.		Remarks.
					Rel.	Abs.	Direction.	Vel.	
P. M.	H. m.	M.	M.m.	° C.	P. ct.	g./m ³ .		M.p.s.	
6 07.3	14,080	108.4	58.7	0.1	22	0.003	S. 66° W.	9.9	2/10 S. Cu. WSW.
6 09.7	14,641	101.0	61.1	0.5	21	0.002	N. 74° W.	7.4	
.....	15,000	.....	61.5	.....	21	0.002	N. 81° W.	7.3
.....	16,000	62.2	21	0.001	S. 83° W.	7.0	Inversion.
6 20.6	17,000	.....	63.0	.....	21	0.001	S. 68° W.	6.8
.....	17,051	67.7	63.1	0.1	21	0.001	S. 67° W.	6.8	
6 28.5	18,000	60.8	21	0.002	S. 2° W.	6.2	Inversion.
.....	18,797	51.4	58.7	-0.3	21	0.003	S. 63° E.	5.7	
.....	19,000	.....	58.7	.....	21	0.003	S. 61° E.	5.3
.....	20,000	57.8	21	0.003	S. 40° E.	3.6	Inversion.
.....	21,000	.....	57.0	.....	21	0.003	S. 30° E.	1.9
6 35.4	21,506	33.5	56.5	-0.1	21	0.004	S. 25° E.	1.0	
.....	22,000	55.6	21	0.004	S. 36° E.	2.0	Balloon burst.
.....	23,000	.....	53.7	.....	21	0.005	S. 59° E.	4.2
6 41.5	23,870	23.0	52.1	-0.1	21	0.006	S. 79° E.	6.1	
.....	23,000	53.6	21	0.005	E.	11.3	Inversion.
6 44.3	23,179	29.7	55.1	1.0	21	0.004	N. 80° E.	16.2	
.....	22,000	.....	53.5	.....	21	0.005	S. 83° E.	12.4
6 45.4	21,321	31.3	61.5	-0.4	21	0.007	S. 76° E.	8.2	Inversion.
.....	21,000	.....	54.3	.....	21	0.005	S. 88° E.	10.9
6 49.0	20,229	40.2	57.2	-0.2	21	0.003	N. 80° E.	13.6	
.....	20,000	57.5	21	0.003	N. 77° E.	12.5	Inversion.
6 51.1	19,098	48.0	59.6	0.0	19	0.002	N. 07° E.	7.8	
.....	19,000	.....	59.6	.....	19	0.002	N. 70° E.	7.7
.....	18,000	60.0	19	0.002	S. 84° E.	6.6	Inversion.
.....	17,000	.....	60.3	.....	19	0.002	S. 67° E.	5.6
6 57.9	16,816	67.9	60.3	-0.4	19	0.002	S. 55° E.	5.5	
7 00.0	16,284	75.3	63.1	-0.2	20	0.001	S. 34° E.	3.7	Inversion.
.....	16,000	.....	63.5	.....	20	0.001	.....	3.6
7 03.1	15,228	89.0	64.7	0.1	19	0.001	N. 45° W.	3.4	
.....	15,000	64.0	19	0.001	N. 58° W.	4.5	Inversion.
7 09.0	14,178	105.3	63.7	0.2	20	0.001	S. 76° W.	8.6	
.....	14,000	.....	63.3	.....	20	0.001	S. 77° W.	8.6
7 11.9	13,498	117.5	63.0	0.2	21	0.001	S. 79° W.	8.6	Inversion.
.....	13,000	.....	61.0	.....	21	0.002	S. 60° W.	8.2
7 15.1	12,734	132.4	60.4	0.0	21	0.002	S. 60° W.	8.2	
7 17.0	12,323	141.4	60.4	0.0	21	0.002	S. 62° W.	10.0	Balloons disappeared.
.....	12,000	60.4	21	0.002	Balloons disappeared.
7 18.9	11,801	153.2	60.2	0.4	21	0.002	.....	.....
7 21.2	11,355	164.7	58.5	0.6	21	0.003	.....	.....
.....	11,000	56.2	21	0.004	Inversion.
7 24.8	10,587	184.9	53.6	0.8	21	0.005	.....	.....
.....	10,000	.....	49.1	.....	22	0.010	.....	.....
7 35.0	9,000	41.6	23	0.023	Inversion.
.....	8,802	248.5	38.6	0.6	24	0.033	.....	.....
7 42.5	8,000	.....	35.0	.....	24	0.049	.....	.....
.....	7,034	310.3	29.4	0.1	25	0.092	Inversion.
7 45.3	7,000	.....	29.4	.....	25	0.092	.....	.....
7 46.8	6,443	336.6	28.6	0.7	30	0.117	.....	.....
.....	6,184	348.7	26.9	0.5	31	0.143	Inversion.
.....	6,000	.....	26.0	.....	33	0.167	.....	.....
7 54.7	5,000	.....	20.8	.....	42	0.347	.....	.....
.....	4,615	431.6	18.8	2.0	46	0.460	Inversion.
7 57.1	4,500	.....	16.6	.....	45	0.548	.....	.....
.....	4,094	461.8	8.6	0.9	41	0.991	.....	.....
7 58.7	4,000	7.8	41	1.057	Inversion.
.....	3,733	484.0	5.4	0.9	39	1.224	.....	.....
.....	3,500	.....	3.4	.....	39	1.441	.....	.....
.....	3,000	1.1	38	1.981	Inversion.
8 04.3	2,980	532.3	1.4	0.4	38	2.021	.....	.....
8 06.0	2,733	548.5	2.5	0.7	39	2.234	.....	.....
.....	2,500	4.1	40	2.549	Inversion.
8 10.3	2,132	590.7	6.8	0.4	41	3.118	.....	.....
.....	2,000	.....	6.3	.....	49	3.607	.....	.....
8 11.5	1,977	602.2	6.2	50	3.656	Inversion.
.....	
.....	

JULY 27, 1913.

[illegible]

JULY 28, 1913.

[illegible]

TABLE 4.—Results of sounding balloon ascensions, Avalon, Cal.—Continued.

JULY 28, 1913—Continued.

Time.	Altitude.	Pressure.	Temperature.	At 100 m.	Humidity.		Wind.		Remarks.
					Rel.	Abs.	Direction.	Vel.	
P. M. h. m.	M.	Mm.	° C.		P. ct.	g./m³.		M.p.s.	
5 50.6	9,000	223.9	-37.8	0.7	15	0.023			
	9,533	223.9	-41.5	0.7	14	0.014			
	10,000		-44.7		14	0.010			
5 55.2	10,399	197.3	-47.2	0.7	14	0.008			
	11,000		-50.6		14	0.005			
6 00.8	11,593	165.2	-53.6	0.5	13	0.003			
	12,000		-55.7		14	0.003			
6 04.9	12,233	149.5	-54.8	0.5	14	0.002			Inversion.
	13,000		-56.0		14	0.003			
6 09.3	13,096	131.0	-55.7	-0.1	14	0.003			Clock stopped at intervals. Time estimated.
6 11.3	13,293	127.1	-55.4	-0.2	13	0.003			Clock stopped, but started again at highest altitude.
	14,000		-55.7		13	0.003			
6 15.5	14,084	112.6	-55.7	0.0	13	0.003			
	19,485	48.1	-56.9	-0.1	13	0.002			
	19,000		-57.5		13	0.002			
	18,010	60.5	-58.3	-0.2	13	0.002			
	18,000		-58.8		13	0.002			
	17,000		-61.4		12	0.001			
	16,489	77.1	-62.6	0.0	12	0.001			Inversion.
	16,063	82.4	-62.4	0.2	12	0.001			
	16,000		-62.2		12	0.001			
	15,000		-60.1		13	0.001			
	14,253	109.6	-58.5		13	0.002			

JULY 29, 1913.

A. M. h. m.	M.	Mm.	° C.	At 100 m.	P. ct.	g./m³.	Direction.	Vel.	Remarks.
11 10.0	34	760.5	18.6		63	9.933	N. 86° W.	2.5	9/10 S. Cu. NW.
11 11.3	418	726.8	15.2	0.9	73	9.393	N. 85° W.	2.5	
	500		14.5		76	9.372	N. 80° W.	2.3	
	1,000		10.6		92	8.913	N. 48° W.	1.3	
11 13.3	1,012	677.0	10.4	0.8	92	8.802	N. 47° W.	1.2	Balloon disappeared in S. Cu. Inversion.
11 14.8	1,330	651.6	9.4	0.3	97	8.713			
	1,500		11.2		76	7.645			
11 16.5	1,684	624.4	12.7	-0.9	55	6.073			
	2,000		12.2		44	4.711			
11 18.4	2,182	588.3	11.9	0.2	37	3.888			
	2,600		11.4		30	3.056			
11 20.2	2,625	557.8	11.3	0.1	27	2.733			
	3,000		9.3		22	1.964			
11 22.9	3,344	511.4	7.4	0.5	18	1.423			
	3,500		6.1		16	1.183			
11 25.7	4,041	469.4	2.2	0.8	12	0.674			
	4,500		2.9		10	0.584			
11 28.6	4,832	424.8	6.2	1.0	9	0.265			Inversion.
	5,000		6.2		9	0.265			
11 29.9	5,120	409.5	6.1	-0.3	9	0.267			
11 33.3	5,953	367.6	-13.4	0.9	7	0.112			
	6,000		-13.4		7	0.112			
11 35.0	6,272	352.7	-14.2	0.3	8	0.119			
11 36.1	6,625	330.2	-18.9	1.3	7	0.089			
11 37.4	6,908	324.5	-19.7	0.3	7	0.064			
	7,000		-20.4		7	0.080			
11 39.2	7,437	301.7	-23.7	0.8	5	0.032			
11 41.0	7,852	283.7	-27.8	0.9	5	0.021			
	8,000		-28.6		5	0.019			
11 43.2	8,570	257.7	-33.2	0.8	6	0.015			
	9,000		-36.4		6	0.011			
11 45.0	9,029	241.7	-36.7	0.8	6	0.010			
11 45.7	9,288	233.6	-38.2	0.9	7	0.010			
11 46.8	9,467	226.9	-39.1	0.5	7	0.009			
11 47.9	9,707	218.9	-42.5	1.4	7	0.006			
11 48.1	9,828	212.2	-42.1	-0.2	7	0.007			Inversion.
	10,000		-43.4		7	0.006			
11 49.4	10,248	202.8	-47.2	1.6	6	0.003			Inversion. One balloon burst and was detached; remaining balloon had sufficient lifting force to continue ascent.
11 53.0	10,633	191.3	-46.9	-0.3					Clock stopped.
11 53.8	10,747	188.2	-47.3	0.4					Balloon burst.
11 53.9	10,794	186.5	-48.3	2.1					
11 55.0	10,915	183.3	-48.7	0.3					
	11,000		-49.3		5	0.002			
	23,000		-44.3	-0.4					
	22,000		-40.5						
	21,305	36.3	-53.0	-0.2					
	21,000		-53.5						
	20,000		-55.2						
	19,000		-56.7						
	18,111	59.7	-58.4	0.0					
	18,000		-58.3						
	17,145	69.5	-58.5	-0.2					
	17,000		-58.7						
	16,141	81.4	-60.4	0.1					Inversion.
	16,000		-60.2						
	15,000		-59.2						
	14,344	107.9	-58.3	0.1	3	0.001			
	14,000		-58.3		3	0.001			
	13,000		-57.6		3	0.001			
	12,386	146.6	-57.3	0.0	3	0.001			
	12,000		-57.3		3	0.001			
	11,368	170.9	-57.3		4	0.001			
	11,000		-50.4		5	0.002			

* Estimated by extrapolation from the ascent.

* Balloon burst; clock started running, but times of this and succeeding levels unknown.

TABLE 4.—Results of sounding balloon ascensions, Avalon, Cal.—Continued.

JULY 30, 1913.

Time.	Altitude.	Pressure.	Temperature.	At 100 m.	Humidity.		Wind.		Remarks.
					Rel.	Abs.	Direction.	Vel.	
A. M.	M	Mm.	° C.		P. ct.	g./m ³ .		M.p.s.	
10 54.0	34	760.0	23.0		61	12.415	NE		Few Cu.
10 57.0	363	731.7	21.0	0.6	67	12.155	SE		
	500		19.9		70	11.913	S		
11 01.0	695	703.8	18.3	0.8	74	11.483	S. 50° W.	0.6	
11 03.0	884	688.3	16.9	0.7	80	11.402	S. 56° W.	1.8	Inversion.
	1,000		18.2		69	10.625	S. 1° W.	1.9	
11 06.0	1,184	664.5	19.9	-1.0	54	9.190	S. 86° W.	2.1	
11 07.3	1,338	652.7	20.4	-0.3	40	7.008	S. 42° E.	5.1	
	1,500		20.7		36	6.418	S. 38° E.	6.4	
11 12.3	1,766	621.1	21.3	-0.2	29	5.353	S. 32° E.	8.7	
11 13.9	1,927	609.5	20.7	0.4	26	4.636	S. 42° E.	12.8	
	2,000		20.3		34	5.922	S. 38° E.	12.4	
11 15.0	2,045	601.3	20.2	0.4	38	6.581	S. 35° E.	12.1	
11 16.9	2,185	591.5	19.6	0.4	45	7.525	S. 33° E.	15.8	Inversion.
11 18.9	2,413	576.7	20.4	-0.4	30	5.256	S. 32° E.	15.2	
11 20.0	2,499	570.3	20.1	0.3	24	4.132	S. 33° E.	14.8	
	2,500		20.0		24	4.108	S. 33° E.	14.8	
	3,000		18.5		15	2.351	S. 25° E.	16.0	
11 26.0	3,067	532.9	18.3	0.3	14	2.169	S. 24° E.	16.2	
11 29.0	3,239	516.7	16.1	0.8	11	1.494	S. 14° E.	17.8	
	3,500		14.8		11	1.381	S. 14° E.	17.2	
	4,000		11.0		10	0.993	S. 16° E.	15.4	
11 37.0	4,133	470.1	10.2	0.7	10	0.945	S. 16° E.	15.0	
11 39.0	4,362	457.3	8.2	0.9	10	0.832	S. 18° E.	17.1	Balloon disapp'd.
	4,500		7.2		10	0.780			Few Cu.
	5,000		3.8		11	0.687			
11 45.0	5,157	414.9	2.7	0.7	12	0.607			
11 49.3	5,749	385.4	-1.1	0.6	9	0.399			
	6,000		-3.5		9	0.330			
11 53.0	6,273	360.8	-6.1	1.0	10	0.296			
11 55.5	6,672	342.7	-9.2	0.8	10	0.230			
	7,000		-9.8		10	0.219			
11 58.5	7,093	324.5	-9.9	0.2	10	0.217			
P. M.									
12 01.0	7,475	309.1	-12.2	0.6	8	0.142			
	8,000		-15.9		8	0.103			
12 09.0	8,915	255.1	-22.1	0.7	7	0.051			
	9,000		-22.8		7	0.048			
	10,000		-30.2		6	0.020			Inversion.
12 16.0	10,322	210.3	-32.6	0.7	6	0.016			
12 17.0	10,521	204.6	-32.4	-0.1	6	0.016			
12 18.8	10,832	195.7	-35.6	1.0	6	0.012			
	11,000		-37.3		6	0.010			
12 22.9	11,724	172.1	-43.6	0.9	6	0.005			
	12,000		-44.2		6	0.004			
12 25.3	12,391	156.1	-44.9	0.2	6	0.004			
12 26.8	12,653	150.2	-48.4	1.3	6	0.003			
	13,000		-49.1		6	0.003			
	14,000		-51.3		6	0.002			
12 32.1	14,021	122.5	-51.3	0.2	6	0.003			Inversion.
	15,000		-49.2		6	0.003			
12 37.0	15,241	102.1	-48.6	-0.2	6	0.003			
12 37.8	15,435	99.3	-51.4	1.4	6	0.002			
	16,000		-50.3		6	0.002			
12 42.3	16,707	81.8	-49.0	0.2	6	0.003			
	17,000		-49.8		6	0.002			
	18,000		-53.0		6	0.002			
12 47.2	18,263	64.7	-53.9	0.3	6	0.001			Inversion.
12 50.1	18,877	58.9	-50.5	-0.6	5	0.002			
	19,000		-50.7		5	0.002			
	20,000		-52.3		5	0.001			
12 53.7	20,131	48.8	-52.5	0.2	5	0.001			Inversion.
	21,000		-51.4		5	0.002			
	22,000		-50.2		5	0.002			
	23,000		-49.0		5	0.002			
1 01.8	23,005	31.5	-49.0	-0.1	5	0.002			
1 03.9	23,932	27.3	-49.5	0.1	5	0.002			Inversion.
	24,000		-49.4		5	0.002			
	25,000		-47.7		5	0.003			
	26,000		-46.2		6	0.004			
	27,000		-44.5		6	0.004			
	28,000		-42.8		6	0.005			
1 11.0	28,062	14.7	-42.7	-0.2	6	0.005			
	29,000		-42.5		6	0.005			
	30,000		-42.4		6	0.005			
	31,000		-42.1		6	0.006			
	32,000		-41.9		6	0.006			
1 20.5	32,043	7.4	-41.8	0.0	6	0.006			
	32,000		-42.1		6	0.006			
	31,000		-42.9		6	0.005			
	30,000		-43.4		5	0.004			
	29,000		-44.0		5	0.004			
	28,000		-44.7		5	0.003			
	27,000		-45.4		5	0.003			
	26,000		-46.0		5	0.003			
1 24.9	25,118	22.7	-46.6	-0.1	3	0.003			
	25,000		-46.8		5	0.003			
	24,000		-48.4		5	0.002			
	23,000		-50.8		5	0.002			
(e)	22,249	35.1	-52.3	0.0	5	0.001			
	22,000		-52.4		5	0.001			
	21,000		-52.6		5	0.001			
	20,000		-53.0		5	0.001			
	19,051	57.2	-53.3	0.1	5	0.001			Inversion.
	19,000		-53.2		5	0.001			
	18,000		-52.4		5	0.001			
	17,000		-51.5		6	0.002			
	16,160	88.6	-50.3		6	0.002			
	16,000		-50.6		6	0.002			

TABLE 4.—Results of sounding balloon ascensions, Avalon, Cal.—Continued.

JULY 31, 1913.

Time.	Altitude.	Pressure.	Temperature.	At 100 m.	Humidity.		Wind.		Remarks.
					Rel.	Abs.	Direction.	Vel.	
A. M.	M.	Mm.	° C.		P.ct.	g./m ³ .		M.p.s.	
10 37.5	34	762.0	22.9		64	12.952			5/10 Cl. S.
10 39.3	388	731.3	18.0	1.4	74	11.261			
10 40.2	500		18.0		74	11.261			
10 40.2	622	711.5	18.1	0.0	74	11.328			
10 41.0	799	696.9	20.5	-1.4	63	11.102	S. 89° E.	1.5	Inversion.
10 41.8	995	681.2	21.7	-0.6	46	8.690	S. 57° E.	5.6	
	1,000		21.6		46	8.640	S. 57° E.	5.6	
10 43.2	1,403	649.7	21.7	0.0	28	5.239	S. 58° E.	6.5	
	1,500		21.0		26	4.717	S. 52° E.	6.2	
10 45.6	1,898	613.4	19.2	0.5	16	2.613	S. 29° E.	5.1	
	2,000		18.7		15	2.379	S. 24° E.	5.8	
10 47.3	2,354	581.4	17.0	0.5	10	1.434	S. 8° E.	8.5	
	2,500		17.0		10	1.434	S. 20° E.	10.8	
10 48.3	2,642	568.6	17.0	0.0	10	1.434	S. 23° E.	11.5	
	3,000		12.8		13	1.444	S. 25° E.	9.4	
10 50.2	3,109	531.7	12.0	0.9	13	1.375	S. 25° E.	8.9	
	3,500		8.8		14	1.210	S. 22° E.	8.0	
10 52.0	3,588	501.7	8.1	0.8	14	1.158	S. 21° E.	7.7	
	4,000		5.8		12	0.855	S. 27° E.	11.2	
10 54.5	4,418	456.2	3.7	0.5	10	0.620	S. 33° E.	15.0	
	4,500		3.7		10	0.580	S. 33° E.	14.6	
	5,000		-1.5		8	0.344	S. 34° E.	12.8	
10 57.3	5,041	419.5	-1.8	0.9	8	0.336	S. 34° E.	12.7	
11 00.2	5,795	381.0	-9.3	1.0	9	0.205	S. 36° E.	13.7	
	6,000		-11.3		10	0.193	S. 35° E.	14.6	
11 03.0	6,557	345.2	-16.7	1.0	12	0.145	S. 32° E.	16.9	
	7,000		-20.6		14	0.118	S. 26° E.	16.2	
11 06.0	7,430	307.0	-24.4	0.9	16	0.094	S. 20° E.	15.7	
	8,000		-28.6		16	0.062	S. 10° E.	14.4	
11 09.0	8,384	269.1	-31.3	0.7	16	0.048	S. 4° E.	13.6	Balloons disappeared in Cirrus clouds.
11 10.0	8,781	254.9	-32.8	0.4	16	0.041			
	9,000		-34.6		16	0.034			
	10,000		-42.2		15	0.014			
11 13.8	10,188	208.4	-43.6	0.8	15	0.012			5/10 Cl. S.
	11,000		-47.4		14	0.007			
11 18.2	11,725	166.0	-51.1	0.5	14	0.005			
	12,000		-52.3		14	0.004			
	13,000		-56.9		13	0.002			
11 21.2	13,165	132.9	-57.6	0.5	13	0.002			Inversion.
11 22.6	13,533	126.0	-58.5	0.2	13	0.002			
	14,000		-56.7		12	0.002			
11 23.9	14,154	114.2	-56.1	-0.4	12	0.002			Inversion.
11 25.4	14,646	106.0	-64.5	-0.3	14	0.003			
	15,000		-55.4		14	0.003			
	16,000		-57.7		12	0.002			
11 29.6	16,166	83.7	-58.1	0.2	12	0.002			Inversion.
11 30.1	16,600	78.1	-58.8	0.2	12	0.001			
11 31.3	16,933	74.4	-58.4	-0.1	12	0.002			
	17,000		-58.6		12	0.001			Inversion.
11 31.8	17,134	72.0	-58.9	0.2	12	0.001			
	18,000		-58.0		12	0.002			
11 34.8	18,607	57.1	-57.6	-0.1	12	0.002			
	19,000		-56.4		13	0.002			
11 36.4	19,580	49.1	-54.6	-0.3	18	0.003			
	20,000		-53.7		13	0.003			
	21,000		-51.9		13	0.004			
11 40.3	21,352	37.4	-51.2	-0.2	13	0.004			Inversion.
11 41.5	21,557	36.2	-51.3	0.1	12	0.004			
	22,000		-49.8		13	0.005			
11 43.0	22,194	32.5	-48.6	-0.4	13	0.006			

AUGUST 1, 1913.

A. M.	M.	Mm.	° C.		P.ct.	g./m ³ .		M.p.s.	
10 36.0	34	761.0	23.9		71	15.210			4/10 Cl. S.
10 36.8	179	748.4	20.0	2.7	74	12.667			Inversion.
10 38.0	365	732.4	22.4	-1.3	66	12.980			
	500		23.1		59	12.077			
10 40.0	707	704.1	24.4	-0.6	46	10.137	S. 8° W.	0.5	
10 40.9	859	691.8	24.7	-0.2	44	9.862	S. 44° E.	2.6	
	1,000		24.2		43	9.369	S. 39° E.	6.6	
10 41.9	1,015	679.6	24.2	0.3	42	9.151	S. 38° E.	7.3	
	1,500		22.0		42	8.072	S. 42° E.	8.1	
10 44.9	1,534	640.0	21.8	0.5	47	7.980	S. 42° E.	8.2	
	2,000		18.3		43	6.661	S. 43° E.	7.0	
	2,500		14.6		44	5.459	S. 44° E.	5.7	
10 51.1	2,555	567.8	14.0	0.8	44	5.263	S. 44° E.	5.5	
	3,000		10.9		48	4.739	S. 36° E.	6.1	
	3,500		7.4		54	4.268	S. 28° E.	6.7	
	4,000		3.6		59	3.367	S. 19° E.	7.4	
10 58.8	4,238	468.7	2.2	0.7	61	3.424	S. 15° E.	7.7	
11 00.7	4,432	451.7	1.9	0.2	44	2.420	S. 4° E.	8.3	
	4,500		1.5		43	2.302	S. 3° E.	8.5	
	5,000		-1.6		39	1.662	S.	10.3	
11 05.5	5,381	400.9	-4.0	0.6	36	1.266	S. 3° W.	11.6	
	6,000		-9.5		37	0.831	S. 7° E.	10.1	
11 09.8	6,233	359.7	-11.6	0.8	37	0.694	S. 12° E.	9.5	Inversion.
11 10.4	6,296	356.7	-10.8	-1.3	38	0.765	S. 8° W.	15.6	
11 11.2	6,426	350.6	-13.7	2.2	37	0.576	S. 12° W.	14.8	
11 12.8	6,880	330.7	-16.8	0.7	37	0.443	S. 6° W.	16.0	
	7,000		-17.5		36	0.406	S. 1° E.	12.5	
11 14.9	7,218	315.8	-18.2	0.4	35	0.371	S. 13° E.	6.6	
	8,000		-23.5		31	0.199	S. 6° E.	8.3	
11 19.2	8,138	279.1	-24.3	0.7	30	0.178	S. 5° E.	8.6	
	9,000		-30.0		30	0.103	S. 2° E.	11.3	
	10,000		-36.6		31	0.054	S. 1° W.	14.3	
11 29.3	10,703	194.6	-41.4	0.7	31	0.031	S. 3° W.	16.5	Balloon disappeared in Ci.

TABLE 4.—Results of sounding balloon ascensions, Avalon, Cal.—Continued.

AUGUST 1, 1913—Continued.

Time.	Altitude.	Pressure.	Temperature.	At 100 m.	Humidity.		Wind.		Remarks.
					Rel.	Abs.	Direction.	Vel.	
A. M.	M.	Mm.	° C.		P.ct.	g./m ³ .		M.p.s.	
11 34.5	11,000		-43.2		31	0.026			
	11,966	161.7	-49.5	0.6	31	0.013			
	12,000		-49.4		31	0.013			
11 36.0	12,366	152.5	-49.8	0.1	30	0.012			
11 37.2	12,827	142.1	-52.4	0.0	30	0.009			
	13,000		-52.3		30	0.009			
11 40.8	13,650	125.4	-52.4	0.0	31	0.009			Inversion
11 42.7	13,977	119.4	-49.8	-0.8	31	0.012			
	14,000		-49.8		31	0.012			
11 45.2	14,778	106.0	-49.8	0.0	30	0.012			
	15,000		-50.5		30	0.011			
	16,000		-54.0		29	0.007			
11 53.9	16,717	78.7	-56.4	0.3	28	0.006			Inversion.
11 55.2	16,849	77.1	-55.5	-0.7	28	0.006			
	17,000		-56.0		28	0.005			
11 57.0	17,493	69.7	-57.3	0.3	28	0.004			
	18,000		-58.0		28	0.004			
12 00.0	18,395	60.6	-58.6	0.1	28	0.003			Inversion.
	19,000		-57.6		29	0.004			
P. M.									
12 03.3	19,993	47.3	-56.2	-0.2	30	0.006			
	20,000		-56.2		30	0.006			
12 06.0	20,195	45.7	-55.9	-0.1	30	0.006			
12 06.7	20,451	44.1	-54.2	-0.7	30	0.007			
12 07.2	20,675	42.6	-55.4	0.5	30	0.006			
	21,000		-55.0		30	0.006			
	22,000		-54.3		30	0.007			
	23,000		-53.5		30	0.008			
12 11.3	23,466	27.7	-53.1	0.2	30	0.008			
	23,000		-51.5		29	0.009			
12 12.6	23,792	30.8	-50.7	-0.1	28	0.010			
	22,000		-51.4		28	0.009			
12 15.6	21,226	38.7	-52.0	-0.2	28	0.008			
	21,000		-52.5		28	0.008			
	20,000		-55.0		28	0.006			Inversion.
12 17.7	19,666	49.8	-55.7	0.4	28	0.006			
12 18.7	19,273	52.9	-54.0	-0.1	28	0.007			Inversion.
12 19.3	19,133	54.1	-55.4	-0.4	28	0.006			
	19,000		-55.7		28	0.006			
12 21.2	18,592	58.8	-57.3	0.4	28	0.004			Inversion.
	18,000		-54.6		29	0.007			
12 23.0	17,453	69.8	-52.4	-0.5	29	0.008			
12 25.3	17,054	74.6	-54.8	0.3	28	0.006			Inversion.
	17,000		-54.6		28	0.006			
12 25.7	16,773	77.7	-54.0	-0.2	28	0.007			
12 26.5	16,414	82.0	-54.8	0.2	29	0.006			Inversion.
	16,000		-53.8		29	0.007			
	15,000		-51.4		29	0.009			
12 32.4	14,227	114.8	-49.5	-0.2	29	0.012			
	14,000		-50.0		29	0.011			
12 34.5	13,254	132.9	-51.5	0.1	28	0.009			Inversion.
	13,000		-51.3		28	0.009			
12 37.6	12,441	150.0	-50.7	0.4	30	0.013			
	12,000		-48.9		30	0.013			
	11,000		-44.9		33	0.023			
12 42.0	10,857	190.0	-44.4	0.1	33	0.024			
	10,000		-37.9		35	0.056			
12 47.5	9,303	237.2	-32.7	0.8	37	0.096			
	9,000		-30.5		36	0.116			
12 51.7	8,188	276.8	-24.3	0.5	33	0.196			
	8,000		-23.5		33	0.212			
12 55.9	7,058	322.6	-19.2	0.9	34	0.326			
	7,000		-18.7		34	0.343			
	6,000		-10.2		38	0.782			
1 00.4	5,719	384.0	-7.7	0.7	36	0.936			
1 02.8	5,115	414.9	-3.6						
	5,000		-3.0		37	1.411			

TABLE 4.—Results of sounding balloon ascensions, Avalon, Cal.—Continued.

AUGUST 2, 1913—Continued.

Time.	Altitude.	Pressure.	Temperature.	dt 100m.	Humidity.		Wind.		Remarks.
					Rel.	Abs.	Direction.	Vel.	
A. M.	M.	Mm.	°C.		P. ct.	g./m ³ .		M.p.s.	
11 42.5	6,780	336.8	-12.7	0.8	16	0.272	S. 7° W.	9.2	
	7,000		-14.4		16	0.235	S. 5° W.	9.6	
11 48.0	7,912	289.8	-21.7	0.8	15	0.114	S. 4° E.	11.9	
	8,000		-22.5		15	0.105	S. 2° E.	11.5	
	9,000		-28.5		14	0.055	S. 21° W.	11.0	
11 53.2	9,086	247.1	-29.0	0.6	14	0.053	S. 23° W.	10.9	
	10,000		-37.1		13	0.021	S. 26° W.	10.8	
12 00.0	10,591	199.3	-42.2	0.9	13	0.012	S. 28° W.	10.7	
P. M.									
	11,000		-45.6		13	0.008	S. 29° W.	11.0	
	12,000		-54.0		12	0.003	S. 30° W.	11.8	
12 05.5	12,031	161.1	-54.4	0.8	12	0.003	S. 30° W.	11.8	
	13,000		-55.2		13	0.003	S. 21° W.	21.7	
12 09.4	13,168	135.4	-55.3	0.8	13	0.003	S. 20° W.	23.3	Inversion.
12 11.0	13,449	130.0	-54.0	-0.5	13	0.003	S. 8° W.	19.3	
12 12.5	13,815	122.7	-55.0	0.3	13	0.003	S. 8° W.	24.3	Inversion.
	14,000		-54.1		13	0.003	S. 8° W.	23.0	
12 14.1	14,284	114.4	-52.8	-0.5	13	0.004	S. 8° W.	20.8	
12 16.1	14,541	110.1	-54.1	0.5	12	0.003	S. 31° W.	18.3	Inversion. One balloon burst and became detached: the remaining balloon had sufficient lifting force to continue ascent.
12 17.3	14,799	106.7	-50.3	-1.5	12	0.005	S. 50° W.	14.7	
	15,000		-50.9		12	0.004	S. 44° W.	18.4	
12 22.6	15,437	96.0	-52.1	0.3	12	0.004	S. 30° W.	27.2	
	16,000						S. 4° E.	19.7	
12 32.0	16,890						S. 59° E.	7.4	Balloon disappeared. Few Cu.
12 56.4	21,302	35.5	-40.0	-0.5	10	0.012			
	21,000		-42.5		10	0.009			
	20,000		-50.6		10	0.004			
	19,000		-58.8		10	0.001			
12 57.9	18,990	53.9	-58.7	-0.3	10	0.001			
	18,000		-61.8		10	0.001			
	17,000		-63.9		10	0.001			
	16,000		-66.6		10	0.001			
1 00.0	15,328	89.0	-67.3	0.5	10	0.001			Inversion.
	15,000		-63.2		11	0.001			
	14,000		-58.5		13	0.002			
1 01.8	13,908	120.5	-58.0	0.0	13	0.002			
	13,000		-57.6		13	0.002			
	12,000		-57.3		13	0.002			
1 03.3	11,898	164.5	-57.1		13	0.002			

* Clock stopped. Altitude computed from ascensional rate.

AUGUST 3, 1913.

P. M.	34	756.9	26.3		62	15.199			Few Cu. over mountains on mainland. Inversion.
5 07.0									
5 07.7	233	739.8	24.1	1.1	62	13.433			
	500		30.0		40	12.014			
5 09.4	541	714.4	30.8	-2.2	37	11.604			
5 10.3	754	687.5	30.3	0.2	25	7.632	N. 65° W.	2.7	
5 11.3	879	687.7	30.6	-0.2	18	5.585	N. 65° W.	6.4	
	1,000		30.0		14	4.205	N. 62° W.	5.8	
5 13.0	1,079	672.3	30.5	0.5	11	3.218	N. 60° W.	5.4	
5 14.0	1,284	656.9	28.1	0.7	11	2.979	S. 81° W.	5.3	
	1,500		26.2		12	2.925	S. 75° W.	5.0	
	2,000		21.8		15	2.850	S. 60° W.	4.5	
5 19.9	2,398	577.7	18.4	0.9	17	2.649	S. 49° W.	4.0	
	2,500		17.7		17	2.541	S. 46° W.	4.2	
5 22.8	2,838	548.7	15.8	0.6	17	2.268	S. 36° W.	4.9	
	3,000		14.6		17	2.109	S. 25° W.	5.2	
	3,500		10.7		16	1.560	S. 9° E.	6.1	
5 28.0	3,804	488.8	8.4	0.8	15	1.264	S. 30° E.	6.6	
	4,000		7.3		15	1.178	S. 9° E.	5.2	
5 31.0	4,459	451.3	4.5	0.6	14	0.916	S. 39° W.	1.8	
	4,500		4.2		14	0.898	S. 42° W.	1.8	
5 34.0	4,966	422.0	0.2	0.9			S. 73° W.	2.2	
	5,000		0.5				S. 73° W.	2.3	
5 37.0	5,533	394.7	-3.3	0.7			S. 79° W.	4.8	
5 39.0	5,792	381.8	-6.6	1.1			S. 45° W.	4.6	
	6,000		-8.2				S. 44° W.	4.2	
	7,000		-17.0				S. 22° W.	2.5	
5 45.8	7,188	318.9	-17.4	0.8			S. 18° W.	2.2	
	8,000		-24.5				S.	3.5	
5 52.0	8,308	273.7	-27.2	0.9			S. 7° E.	4.0	
	9,000		-31.1				S.	5.9	
5 58.0	9,573	229.7	-34.4	0.6			S. 6° W.	7.6	
	10,000		-38.8				S. 7° W.	7.7	
6 04.8	10,790	193.0	-41.6	0.6			S. 8° S.	7.9	
	11,000		-42.7				S. 9° W.	9.4	
	12,000		-49.2				S. 14° W.	16.4	
6 10.0	12,050	160.6	-49.7	0.7			S. 14° W.	16.8	
6 16.1	12,836	140.8	-49.9	0.0			S. 5° W.	22.3	
	13,000		-50.1				S. 7° W.	21.3	
6 18.1	13,315	132.8	-51.3	0.4			S. 16° W.	16.7	

TABLE 4.—Results of sounding balloon ascensions, Avalon, Cal.—Continued.

AUGUST 3, 1913—Continued.

Time.	Altitude.	Pressure.	Temperature.	dt 100m.	Humidity.		Wind.		Remarks.
					Rel.	Abs.	Direction.	Vel.	
P. M.	M.	Mm.	°C.		P. ct.	g./m ³ .		M.p.s.	
6 24.0	14,729	107.0	-56.8	0.4			S. 22° W.	18.4	
	15,000		-59.2				S. 29° W.	20.3	
6 29.0	15,794	90.8	-65.7	0.8			S. 23° W.	18.2	
6 30.1	15,975	88.2	-65.3	-0.2			S. 4° W.	12.2	Inversion.
	16,000		-65.3				S. 27° E.	9.4	
	16,611	79.4	-67.5	0.3			S. 26° E.	9.4	
6 34.0	16,714	78.1	-66.9	-0.6			S. 2° W.	9.2	Inversion.
6 35.7	16,895	76.0	-62.4	-2.5			S. 34° E.	5.3	
	17,000		-62.3				S. 45° E.	9.1	
6 38.4	17,428	69.4	-61.8	0.0			S. 31° E.	9.6	
	17,000		-61.5				S. 84° E.	11.4	
6 40.0	16,492	79.9	-61.2	-0.6			S. 32° E.	17.9	
	16,000		-64.3				N. 32° E.	25.8	
6 41.7	15,838	88.6	-65.4	0.0			S. 71° E.	12.5	
6 44.1	15,208	97.8	-65.4	0.6			S. 45° E.	7.8	Inversion.
	15,000		-64.0				S. 10° W.	20.3	
	14,000		-57.9				S. 11° W.	19.6	
6 50.0	13,118	135.3	-52.4	0.2			S. 15° W.	16.5	
	13,000		-52.2				S. 18° W.	13.7	
	12,000		-50.2						
6 54.3	11,782	166.0	-49.9	0.7					
	11,000		-44.5						
7 00.3	10,052	213.6	-37.8	0.8					
	10,000		-37.5						
7 04.2	9,000		-29.4						
	8,539	263.6	-25.9	0.7					
7 10.0	8,000		-22.4						
	7,080	321.0	-16.2	0.6					
	7,000		-15.7						
7 17.7	6,000		-9.4						
	5,275	405.3	-5.0	0.6					
	5,000		-3.2						
	4,500		0.0						
7 24.1	4,000		3.1						
	3,792	487.7	4.3	0.8					
	3,500		6.6						
	3,000		10.6						
7 30.4	2,500		14.5						
	2,187	691.5	17.0	1.0					
	2,000		18.9						
7 34.1	1,500		23.9						
	1,208	662.5	26.7	0.9					
	1,000		28.5						
7 35.9	849	690.0	29.8	0.4					
7 36.7	718	700.3	30.3						

AUGUST 7, 1913.

P. M.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
-------	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 4.—Results of sounding balloon ascensions, Avalon, Cal.—Concluded.

AUGUST 8, 1913.

Time.	Altitude.	Pressure.	Temperature.	At 100 m.	Humidity.		Wind.		Remarks.
					Rel.	Abs.	Direction.	Vel.	
P. M.	M.	Mm.	° C.		P. ct.	g./m ³	S. 32° W.	M. p. s.	
5 23.5	34	755.6	20.0	0.8	75	12.838	S. 32° W.	4.3	4/10 S. Cu. SSE.
5 25.1	367	726.6	17.2	0.8	80	11.608	S. 32° W.	4.3	
5 26.7	500	691.5	16.4	0.7	82	11.342	S. 62° W.	3.3	Balloon in S. Cu.
	786		14.4		88	10.785	N. 55° W.	0.9	NW. Inversion.
5 27.4	1,000		19.8		67	11.336	N. 6° E.	1.9	
5 28.4	1,021	672.6	20.4	-2.6	64	11.213	N. 12° E.	2.0	
5 29.1	1,122	664.7	21.8	-1.4	56	10.640	N. 16° E.	0.4	
5 29.5	1,214	655.4	24.5	-2.2	49	10.859	S. 69° E.	0.2	
5 29.5	1,413	642.9	24.9	-0.2	45	10.200	S. 77° W.	1.0	
5 30.2	1,500		24.4		43	9.476	N. 82° W.	1.5	
5 30.7	1,539	633.6	24.2	0.6	42	9.151	N. 73° W.	1.8	Inversion.
5 30.7	1,711	621.3	24.3	-0.1	41	8.984	N. 45° W.	5.2	
5 32.3	2,000		23.1		39	7.983	N. 21° W.	6.0	
5 32.3	2,080	595.4	22.6	0.5	39	7.758	N. 15° W.	6.2	
5 34.3	2,500		19.3		40	6.572	N. 25° W.	3.6	
5 34.3	2,619	559.2	18.4	0.8	40	6.233	N. 28° W.	2.8	
5 36.9	3,000		14.6		41	5.055	N. 20° W.	4.1	
5 36.9	3,316	514.7	11.4	1.0	41	4.176	N. 13° W.	5.2	
5 40.5	3,500		9.8		43	3.961	N. 10° W.	4.6	
5 40.5	4,000		5.8		46	3.278	N. 2° W.	3.2	
5 43.4	4,198	462.6	4.2	0.8	48	3.079	N. 1° E.	2.7	
5 43.4	4,500		2.2		50	2.806	N. 17° W.	3.0	
5 46.8	4,981	419.9	-0.9	0.7	53	2.387	N. 45° W.	3.4	
5 47.1	5,000		-1.0		53	2.368	N. 45° W.	3.4	
5 48.0	5,932	399.6	-6.5	0.6	57	1.634	S. 50° W.	3.0	
5 49.2	5,997	368.4	-6.9	2.7	59	1.637	S. 53° W.	5.8	
5 50.0	6,000		-6.8		58	1.623	S. 53° W.	3.0	
5 50.8	6,299	354.5	-8.7	0.6	58	1.390	S. 75° W.	5.5	Inversion.
5 53.2	6,615		-8.4	-0.1	54	1.326	S. 45° W.	3.6	Pressure pen not recording.
5 54.8	6,840		-8.1	-0.1	52	1.308	S. 22° W.	14.6	Altitude computed from ascensional rate.
5 56.2	7,000		-8.9		50	1.180	S. 11° W.	12.0	
5 56.8	7,050		-9.1	0.5	49	1.137	S. 7° W.	10.7	
5 58.8	7,500		-13.0	0.6	46	0.763	S. 14° W.	11.5	
5 59.8	8,000		-14.5		45	0.655	S. 16° W.	12.8	
5 59.8	8,215		-15.9	0.6	45	0.582	S. 18° W.	14.0	
5 59.8	8,650		-19.5	0.8	45	0.422			6/10 S. Cu. SSE.
5 59.8	8,850		-20.7	0.6	45	0.375			Balloons disappeared in St. Cu.
5 59.8	9,000		-21.3		44	0.348			Observations of ascension were made through this film of St. Cu. which at times obscured balloons after 5 p. m.
5 59.8	9,080		-21.7	0.4	44	0.334			
5 59.8	9,700		-24.3	0.4	43	0.256			
5 59.8	10,000		-26.1		43	0.215			
5 59.8	10,415		-28.7	0.6	42	0.162			
5 59.8	10,730		-29.8	0.3	42	0.145			
5 59.8	11,000		-31.5		42	0.124			
5 59.8	11,575		-35.0	0.6	42	0.086			
5 59.8	12,000		-35.8		41	0.077			
5 59.8	12,080		-36.0	0.2	41	0.076			
5 59.8	12,700		-37.2	0.2	40	0.065			
5 59.8	13,000		-38.7		40	0.055			
5 59.8	13,250		-39.8	0.5	40	0.049			
5 59.8	14,000		-43.4		40	0.033			
5 59.8	14,100		-43.9	0.5	40	0.031			

AUGUST 10, 1913.

A. M.									
4 43.0	34	765.9	23.4	0.5	58	12.077	N. 46° E.	2.8	Cloudless.
4 45.7	435	722.6	21.3	0.5	57	10.522	N. 24° E.	1.1	Inversion.
4 48.2	500		21.9		52	9.937	N. 5° E.	1.7	
4 48.2	832	690.3	24.7	-0.9	27	6.052	N. 89° W.	4.0	
4 49.2	1,000		24.5		21	4.654	S. 88° W.	3.5	
4 49.2	1,036	674.3	24.5	0.1	20	4.432	S. 87° W.	3.4	
4 52.4	1,500		23.3		15	3.106	N. 47° W.	2.3	
4 54.9	1,549	635.7	23.2	0.3	14	2.882	N. 42° W.	2.1	
4 54.9	1,978	604.8	19.3	0.6	15	2.464	N. 47° W.	2.1	One balloon became detached; the other balloon with the meteorograph slowly descended.
5 00.9	2,000		19.0		15	2.421	N. 47° W.	2.1	
5 00.9	1,500		21.0		13	2.358	N. 43° W.	2.2	
5 00.9	1,385	647.8	21.5	0.7	13	2.428	N. 42° W.	2.2	
5 03.0	1,253	657.7	22.4	0.8	9	1.770	N. 23° W.	2.1	
5 09.0	1,000		24.5		8	1.773	N. 44° W.	1.8	
5 09.0	785	694.2	26.2	-0.3	7	1.708	N. 61° W.	1.5	
5 11.0	702	700.8	24.1	0.2	7	1.517	N. 68° W.	3.9	Inversion. Balloon disappeared behind the mountains.
5 13.1	600	709.0	24.3	-0.5	7	1.534			
5 16.6	360	728.9	23.0	-1.8	16	3.389			
5 18.3	263	737.1	21.3		27	5.495			
					44	8.122			Inversion.

(b) THE CAPTIVE BALLOON AND MOUNTAIN OBSERVATIONS ON AND NEAR MOUNT WHITNEY.

By W. R. GREGG.

Meteorological observations, including some captive balloon ascensions, were made at Mount Whitney, Cal., from August 1 to 13, inclusive, and at Lone Pine, Cal., from August 1 to 4, inclusive. Mount Whitney is the highest peak of the Sierra Nevadas, its altitude being 4,420 meters. It lies in latitude 36° 35' N. and longitude

118° 17' W. On the north, south, and west it is surrounded by mountains, many of which are nearly as high as itself; its eastern slope is quite precipitous and at its foot lies Owens Valley, which is about 25 kilometers in width and extends in a north-northwest and south-southeast direction. East of this valley and running parallel to the Sierras is the Inyo Range, altitude about 3,000 meters. Lone Pine is situated about midway between these two ranges, near the northern end of Owens Lake. Its altitude is 1,137 meters and it lies in latitude 36° 35' N. and longitude 118° 3' W., about 25 kilometers due east from Mount Whitney. Topographically the location of Lone Pine is similar to that of Independence, Cal., which is about 25 kilometers north-northwest of it and therefore practically the same distance from Mount Whitney. Independence is in latitude 36° 48' N., longitude 118° 12' W., and has an altitude of 1,191 meters, or 54 meters higher than that of Lone Pine.

SURFACE OBSERVATIONS AT MOUNT WHITNEY.

The instrumental equipment consisted of a Short and Mason aneroid barometer, sling psychrometer, small kite anemometer of the Robinson type, Marvin meteorograph, and Richard meteorograph. The Richard instrument recorded pressure and temperature only and the object in taking it was to obtain a surface record of these elements and also to provide a substitute in case the Marvin instrument were lost or injured. The latter recorded relative humidity in addition to pressure and temperature. In order to secure good ventilation during balloon ascensions a section of the horizontal screening tube containing the humidity and temperature elements had been cut out, thus exposing these elements directly to the air.

As soon as they were unpacked, both of these instruments were started recording and a continuous record of pressure, temperature, and relative humidity was obtained. The sheets were changed at 8 a. m. and 5 p. m., and eye readings of the aneroid barometer and psychrometer were taken at these times—at 11 a. m. and 2 p. m., and during balloon ascensions. In addition, readings of the psychrometer were taken by Messrs. A. K. Angström and E. H. Kennard, representing the Smithsonian Institution, during the nights when they were observing. These readings have also been used to check the meteorograph records.

The exposure of the instruments was fairly good. They were kept in an improvised shelter constructed from the boxes in which they were "packed" to the summit. The ventilation was good, but during those afternoons in which the sun shone, the air in the shelter was considerably heated. However, there were only four sunny afternoons, and furthermore the eye readings at 2 p. m. and 5 p. m. leave but little interpolation necessary.

All of the instruments were calibrated before and after the expedition. Especial care was taken in the calibration of the aneroid barometer, tests being made to determine the correction for "lag" or "creeping" and for changes in temperature. The effect of the latter was found to be negligible.

Owing to the large scale value of the pressure elements in the meteorographs and to the effect of changes of temperature on those elements, it is impossible to obtain with much accuracy the hourly values. However, in Table 5 are given the pressures observed at certain hours. The readings at 11 a. m. are uniformly higher than those at 8 a. m., 2 p. m., or 5 p. m. It is probable that the diurnal maximum occurs at about this time.

The range of pressure for the entire period is large, about 8 mm. The range for the same period at Independence is much less, about 5 mm. At both places the lowest readings were recorded on August 8 and 9, while a cyclonic disturbance was central over northern California. This low was attended by considerable cloudiness, with thunderstorms, and, at Mount Whitney, snowstorms. The greater pressure range at Mount Whitney than at Independence is accounted for by the cool weather during the passage of the low and the consequent crowding together of the isobars in the lower levels.

Tables 6, 7, and 8 contain the hourly values of temperature, relative humidity, and absolute humidity, respectively. Means have been computed for the 10

prevailed. However, the values at both places, compared with those at the same altitude above Mount Weather, indicate that in summer temperatures on mountains are higher than those in the free air, although difference in latitude, in this case about $2\frac{1}{2}^{\circ}$, should be considered. The times of maximum and minimum temperatures at Mount Whitney were 3 p. m. and 5 a. m., respectively; at Pikes Peak they were 1 p. m. and 5 a. m., respectively.

Figure 10 shows mean hourly temperatures at Mount Whitney and Independence and for the same period during 1893 and 1894 at Pikes Peak. The range at the latter appears to be somewhat smaller than at Mount Whitney, and this may be due to the fact that conditions at Pikes Peak are more nearly like those of the free air,

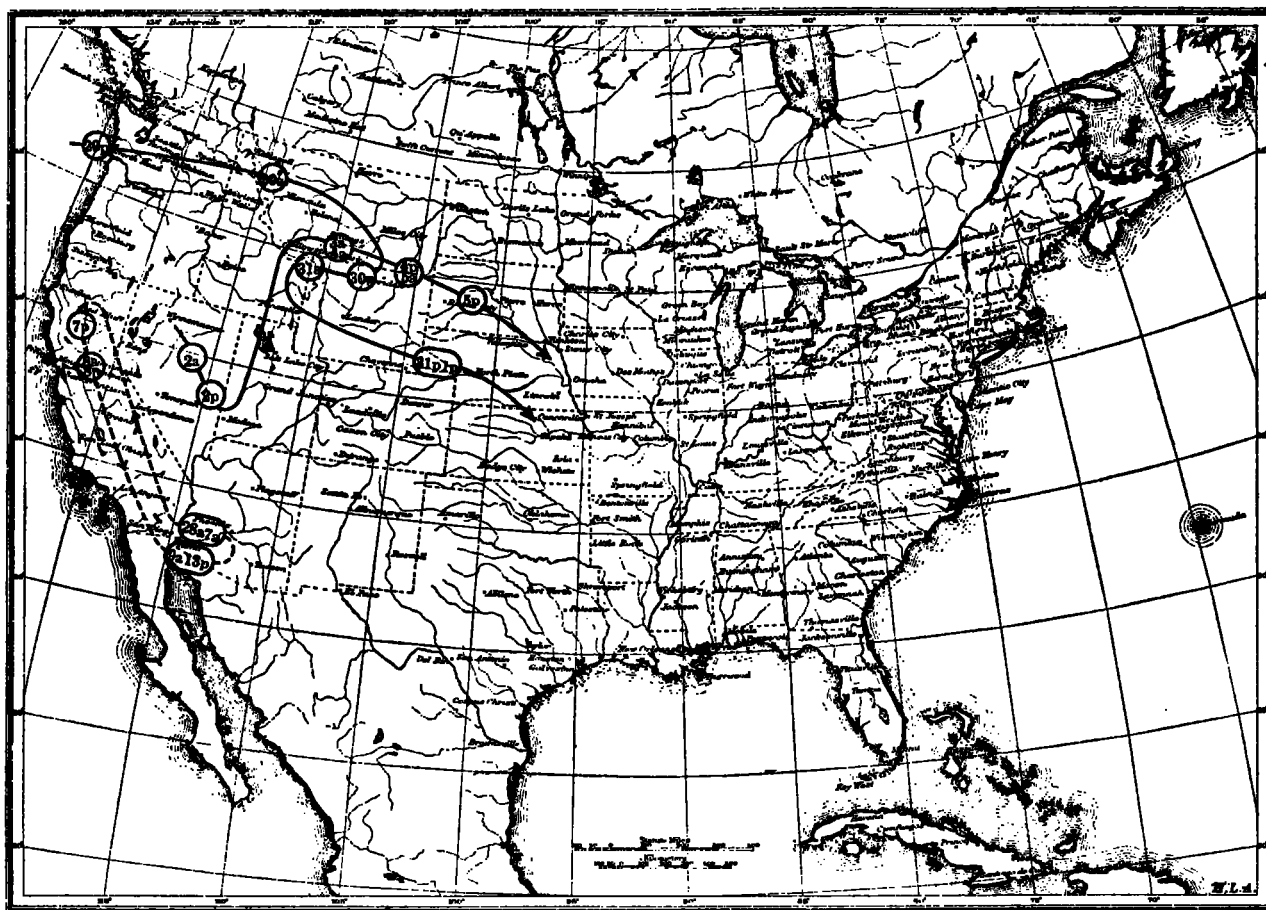


FIG. 8.—Pressure distribution in the western United States, July 29–August 13, 1913.

complete days, August 3 to 12, inclusive. Final conclusions may not be drawn from so short a record, but a few comparisons are of interest. The mean temperature was 0.7°C .; that in the free air at the same altitude and for the same time of year, as determined from five years' observations at Mount Weather, Va., is -2.0° . The mean temperature at Pikes Peak¹ for these 10 days in 1893 and 1894 was 2.8° . Pikes Peak has an altitude of 4,301 meters, or about 100 meters below that of Mount Whitney, and to correct for this difference in altitude about $0^{\circ}.6$ should be subtracted from the value at Pikes Peak. The temperature at Mount Whitney was undoubtedly below normal, owing to the severe stormy weather which

owing to its isolation and the consequent freer circulation. The curve for Independence shows the large diurnal range characteristic of valley stations. Beneath the mean temperatures for Mount Whitney in Table 6 are given the means for the same period at Independence and the differences in temperature change per 100 meters altitude between the two places. The temperature change with altitude during the night hours is somewhat misleading, owing to a marked inversion of temperature between the surface of the valley and about 200 meters above it, as will be pointed out in discussing the Lone Pine observations. The hourly differences between Independence and Mount Whitney during the daytime are large, averaging about 0.85. The mean for the 24 hours is 0.73.

¹Annual Reports of Chief U. S. Weather Bureau, 1893, 1894, 1895-96, Washington.

TABLE 5.—Pressures at Mount Whitney, Cal., Aug. 1-13, 1913.

Date.		Hours.																								Means.
		A. M.												P. M.												
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
1913.					Mm.			Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.		Mm.			Mm.	Mm.			Mm.	
Aug. 1																		447.0								
2																		446.0								
3										446.8	447.0	447.6	447.0	448.8	448.5			446.0				446.3	446.5			446.0
4										446.8								445.8				448.3				
5										445.5		446.3						445.5								
6										444.2		445.0						444.5				444.8				
7										444.8		445.3						443.5								
8										442.7		442.5						441.4								
9										438.7		439.2						438.9								
10										440.4		441.2						440.4								
11										441.4		442.0						441.7								
12										440.9		441.7						440.9								
13					438.7													440.4								

TABLE 6.—Hourly temperatures at Mount Whitney, Cal., Aug. 1-13, 1913.

Date.	Hours.																								Means.
	A. M.												P. M.												
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
1913.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	
Aug. 1																									
2																			1.1	-0.1	-0.6	-1.1*	-1.2	-2.9*	
3	-1.4*	-1.9*	-2.1	-3.8	-2.9	-2.5	-1.8	0.0*	1.0	2.2*	1.7*	3.9*	2.3*	3.1*	6.1*	5.6	4.8	3.2	1.4*	0.2*	-0.2*	0.0	-0.1*	-0.4*	0.8
4	-0.6*	-1.1*	-1.1	-1.3*	-1.7*	-1.8	-1.0	-0.7*	-0.7	0.7	2.1	3.9*	4.4	4.8*	4.9	5.0	4.7*	4.5	1.9*	1.4*	1.3*	1.1*	0.6*	0.6*	1.3
5	0.0*	0.2*	0.2*	0.1*	-0.3	-0.1	0.9	1.8*	1.7	3.0	4.2*	5.0	5.8	6.6*	7.0	5.5	4.3*	4.0	1.9*	1.8*	1.2*	1.1*	1.1*	0.6*	2.4
6	0.3*	0.6*	0.3*	0.6*	(0.6)	(1.2)	(1.6)	2.0*	2.3	3.8	5.1*	5.6	6.2	6.2*	6.4	6.6	7.8*	7.5	4.5	2.5*	2.2	2.1	2.0	2.0	3.3
7	1.9	1.8	1.7	1.6	1.6	1.6	1.7	1.9*	3.0	3.3	4.4*	5.2	5.0	6.7*	7.0	6.8	3.9*	4.4	3.8	1.9	1.4	1.5	1.5	1.4	3.2
8	1.0	0.7	0.5	0.5	0.5	0.4	0.5	1.3*	1.3	-0.2	-0.7*	0.2	0.2	-0.8*	-0.3	0.3	1.0*	1.0	0.2	-0.6	-1.1	-1.3*	-1.4	-1.4	0.1
9	-1.5	-1.5*	-1.5	-1.5	-1.5	-1.7	-1.8	-2.0*	-2.4	-0.4	-1.3*	-1.0	-0.5	-0.2*	-2.0	-1.1	-1.1*	-1.3	-2.3	-2.2	-2.2	-2.4	-2.6	-2.7	-1.6
10	-3.1	-3.4	-3.6	-3.7	-3.7	-3.2	-1.9	-0.9*	-1.0	-0.8	-0.2*	0.0	-0.7	-0.5*	-0.5	-3.0	-0.7*	-0.9	-1.2	-1.7	-2.2	-2.3	-2.3	-2.4	-1.8
11	-2.4	-2.4	-2.5	-2.7	-2.8	-2.8	-2.8	-2.6*	-2.6	-1.0	-0.1*	0.3	1.4	2.2*	2.7	2.5	2.4*	2.0	-0.6	-2.2*	-2.3*	-2.4*	-2.7*	-2.8	-1.0
12	-3.0*	-2.8	-2.6*	-2.5*	-2.5	-2.5	-1.4	-0.2*	-0.2	1.3	2.5*	3.4	4.4	5.2*	5.6	4.0	4.0*	4.0	-0.3	-1.2	-1.4	-1.6	-1.3	-1.4	0.4
13	-2.0	-2.4	-2.5	-2.6	-3.3*																				
Means	-0.8	-1.0	-1.1	-1.2	-1.5	-1.1	-0.6	0.1	0.2	1.2	1.8	2.6	2.9	3.3	3.7	3.2	3.1	2.8	0.9	0.0	-0.3	-0.4	-0.5	-0.6	0.7
Independence	18.6	17.8	17.2	16.8	16.5	16.7	20.4	22.9	25.2	26.9	29.2	30.6	31.2	31.4	31.4	31.3	29.9	27.7	26.1	25.3	23.7	22.0	20.4	19.8	24.1
4 ft per 100m	0.60	0.58	0.57	0.54	0.55	0.55	0.65	0.71	0.78	0.80	0.85	0.87	0.88	0.87	0.86	0.87	0.83	0.77	0.78	0.79	0.75	0.70	0.65	0.63	0.73

* Eye readings.

TABLE 7.—Hourly relative humidities at Mount Whitney, Cal., Aug. 1-13, 1913.

Date.	Hours.																								Means.
	A. M.												P. M.												
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
1913.																									
Aug. 1																									
2																							97*	93*	73
3	92*	92*	(80)	42	(50)	(80)	(70)	79*	(80)	80*	79*	74*	81*	76*	55*	60	68	71	80*	78*	85*	78	70*	72*	73
4	69*	71*	55	36*	45*	50	64	64*	68	(74)	77	77*	72	51*	60	62	62*	67	75*	66*	51*	45*	52*	51*	61
5	52*	52*	47*	50*	51	52	55	56*	48	40	32*	34	34	36*	40	45	40*	52	54*	51*	55*	43*	38*	42*	46
6	43*	40*	29*	34*	(42)	(50)	(58)	67*	64	50	57*	(58)	(59)	60*	58	57	57*	55	58	70	70	70	70	66	56
7	68	68	69	69	69	69	69	69*	68	65	63*	63	64	64*	66	68	70*	75	100	100	95	94	93	93	75
8	93	93	92	92	92	91	85	78*	80	92	93*	96	100	100*	100	100	82*	82	84	85	86	86*	84	85	90
9	86	87*	87	87	88	90	94	95*	95	(92)	89*	85	90	100*	100	98	97*	99	100	100	100	99	99	98	94
10	96	93	90	85	80	85	87	86*	85	86	95*	93	92	91*	88	100	93*	94	100	100	94	99	100	100	92
11	100	100	100	96	94	94	63	50*	41	41	41*	41	41	41*	45	73	77*	72	67	63*	41*	40*	33*	31	62
12	31*	26	20*	18*	18	30	40	50*	48	46	43*	43	43	43*	47	56	62*	50	72	76	54	54	15	15	42
13	15	19	19	19	23*																				
Means	73	72	67	61	63	67	68	69	68	67	67	66	68	66	66	72	72	72	79	79	73	71	65	66	69

TABLE 8.—Absolute humidities in grams per cubic meter at Mount Whitney, Cal., Aug. 1-13, 1913.

Date.	Hours.																								Means.
	A. M.												P. M.												
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
1913.																									
Aug. 1																							3.7*	4.0*	
2	4.0*	3.8*	(3.3)	1.6	(1.9)	(2.4)	(2.9)	3.8*	(4.1)	4.5*	4.3*	4.7*	4.6*	4.5*	4.0*	4.2	4.5	4.3	4.3*	3.8*	4.0*	3.8	3.4*	3.4*	
3	3.2*	3.1*	2.4	1.6*	1.9*	2.1	2.9	2.9*	3.1	(3.8)	4.3	4.8*	4.7	3.4*	4.0	4.2	4.1*	4.4	4.1*	3.5*	2.7*	2.3*	2.6*	2.6*	
4	2.6*	2.5*	2.3*	2.4*	2.4	2.5	2.8	3.1*	2.6	2.4	2.1*	2.3	2.4	2.7*	3.1	3.1	3.2*	3.3	3.0*	2.8*	2.9*	2.2*	2.0*	2.1*	
5	2.1*	2.0*	1.4*	1.7*	(2.1)	(2.6)	(3.1)	3.7*	3.6	3.1	3.9*	(4.1)	(4.3)	4.4*	4.3	4.3	4.6*	4.4	3.8	4.0*	3.9	3.9	3.9	3.7	
6	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.8*	4.0	3.9	4.1*	4.3	4.6	4.8*	5.1	5.2	4.4*	4.9	6.2	5.5	5.1	5.0	5.0	4.9	
7	4.8	4.7	4.6	4.6	4.6	4.5	4.3	4.1*	4.2	4.4	4.3*	4.7	4.9	4.5*	4.7	4.9	4.2*	4.2	4.1	3.9	3.8	3.8*	3.6	3.7	
8	3.7	3.7	3.7	3.7	3.8	3.8	3.9	3.9*	3.8	(4.3)	3.9*	3.8	4.2	4.8*	4.1	4.3	4.3*	4.3	4.0	4.1	4.1	4.0	3.9	3.8	
9	3.6	3.4	3.3	3.1	2.9	3.2	3.6	3.9*	3.8	3.9	4.5*	4.5	4.2	4.2*	4.1	3.8	4.3*	4.2	4.4	4.2	3.8	4.0	4.0	4.0	
10	4.0	4.0	4.0	3.7	3.6	3.6	2.4	2.0*	1.6	1.9	2.0*	2.0	2.2	2.3*	2.6	4.2	4.4*	4.0	3.1	2.6*	1.7*	1.6*	1.3*	1.2	
11	1.2*	1.0	0.8*	0.7*	0.7	1.2	1.7	2.4*	2.3	2.4	2.5*	2.6	2.8	2.9*	3.3	3.5	3.9*	3.2	3.4	3.3	2.3	2.3	0.7	0.6	
12																									
13	0.6	0.8	0.8	0.7	0.9																				
Means	3.3	3.2	3.0	2.7	2.8	3.0	3.1	3.4	3.3	3.5	3.6	3.8	3.9	3.8	3.9	4.2	4.2	4.1	4.0	3.8	3.4	3.3	3.0	3.0	
																								3.5	

*Indicates eye-readings. () inclose estimated values. All others from meteorograph records.

TABLE 9.—Wind velocities, in meters per second, at Mount Whitney, Cal., during August, 1913.

Date.	Hours.																							
	A. M.												P. M.											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
1913.																								
Aug. 1																								
2																								
3					2.6					1.3	1.8	1.8	1.3	1.3	1.8				2.1		2.6			
4					3.8			*		3.8			2.2	*	1.5	*				3.5		3.8		
5					1.8			*		1.5	*		2.8	*	2.1	*			1.3		2.5			
6					3.4			*		0.9	*		1.9	*	1.2	*					3.4			
7					3.6			*		3.7	*		5.5	*	3.6	*					3.6			
8					3.0			*		2.4	*		3.1	*	1.5	*					3.0			
9					2.0			*		2.8	*		2.4	*	3.7	*					2.0			
10					1.4			*		1.4	*		3.1	*	2.8	*					1.4			
11					3.5			*		4.1	*		3.7	*	3.7	*					3.5			
12					3.7			*		4.9	*		5.7	*		*					3.7			
13					5.6	→									4.6						5.6			

Mean velocity for entire period, 3 m. p. s.

NOTE.—Anemometer read at the times indicated by *; figures are mean velocities between readings.

TABLE 10.—State of weather at Mount Whitney, Cal., during August, 1913.

Date.	Hours.																								Remarks.
	A. M.												P. M.												
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
1913.																									
Aug. 1.																									
2.																									
3.																									
4.																									
5.																									
6.																									
7.																									
8.																									
9.																									
10.																									
11.																									
12.																									
13.																									

The relative humidity, Table 7, was probably higher than normal for this season of the year, owing to the unusually stormy weather and the presence of snow on the ground. The mean was 69 per cent, the mean maximum 79 per cent at 7 to 8 p. m., and the mean minimum 61 per cent at 4. a. m. During the severe storm of August 8, 9, and 10, 100 per cent was frequently recorded. The absolute minimum was 15 per cent at midnight of the 12th.

For the reasons given above, the absolute humidity, Table 8, was also probably higher than normal. The mean was 3.5 grams per cubic meter, the mean maximum 4.2 at 4 to 5 p. m., and the mean minimum 2.7 at 4 a. m. The absolute maximum was 6.2 at 7 p. m. of the 7th and the absolute minimum 0.6 at midnight of the 12th.

Table 9 gives roughly the average wind velocities. Dial readings of the anemometer were made at the times

indicated by stars. The figures between these stars represent average velocities for the intervals between readings. The mean for the entire period was 3.0 m. p. s. That at Pikes Peak for the same time of year was 6.0 m. p. s. This difference may be due partly to the fact that Pikes Peak stands out in the open, whereas Mount Whitney is surrounded by peaks nearly as high as itself, and also to the greater proximity of Pikes Peak to the

Mount Whitney and about 10 meters below it. This was the only spot on the mountain that was fairly level and free from jagged surface rocks. While the balloon was being filled with gas it rested on a large piece of canvas to protect it from rocks and snow. The gas, compressed in steel cylinders, was furnished by the Signal Corps of the United States Army. A hand reel was used for reeling the wire in and out. Readings of the psy-

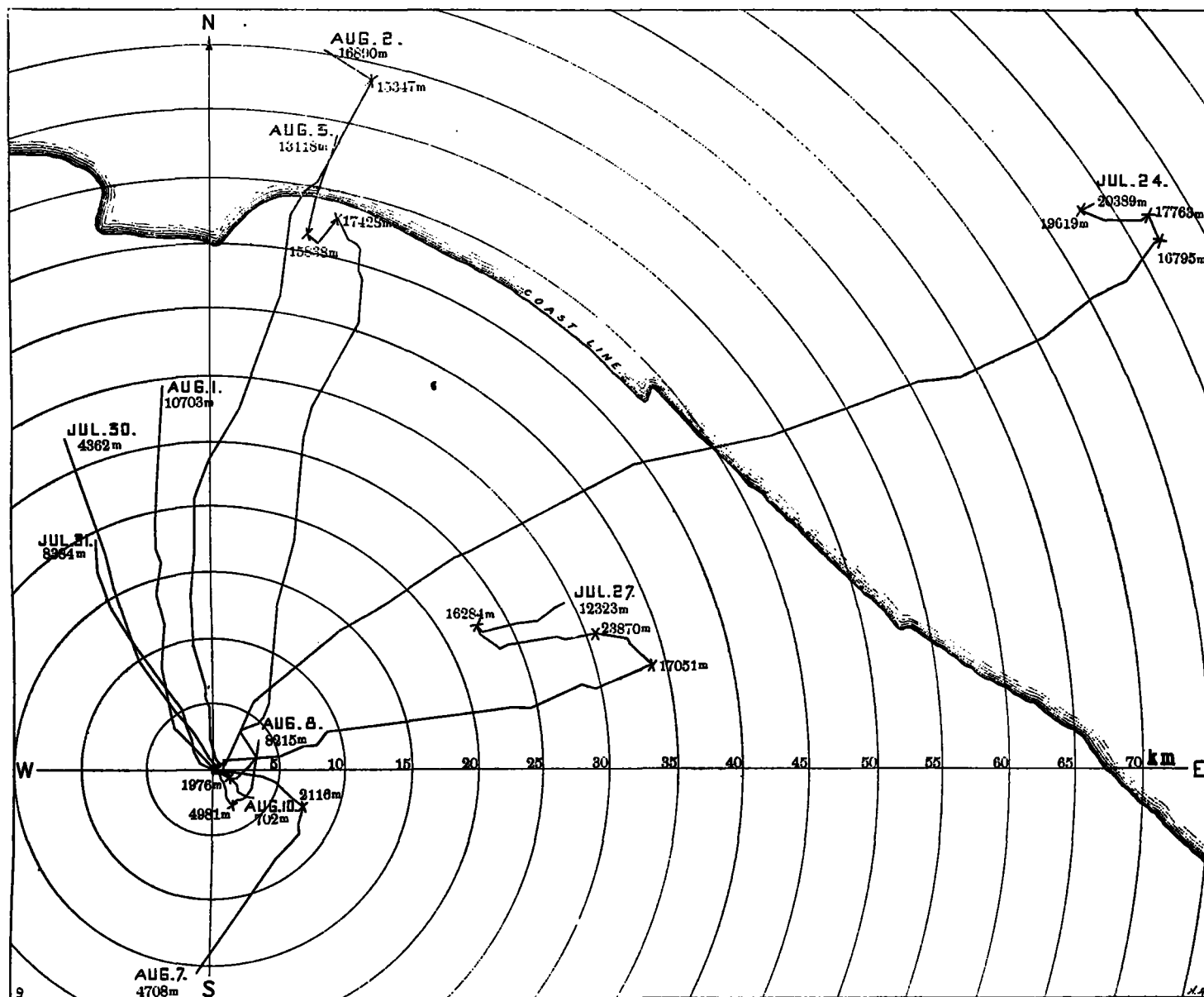


FIG. 9.—Horizontal projections of the paths of the sounding balloons liberated at Avalon, Cal., July 23-August 10, 1913.

cyclonic storm paths of the United States. The prevailing wind direction was southeast, but directions ranging between south and northeast were frequently observed, and a southwesterly wind prevailed during the blizzard of August 9.

In Table 10 may be found the state of the weather for the period, together with notes on storms, kinds of clouds, and miscellaneous phenomena.

FREE-AIR OBSERVATIONS AT MOUNT WHITNEY, CAL.

The place from which balloon ascensions were made was about 60 meters to the northwest of the summit of

chrometer, aneroid barometer, and anemometer were made with the aid of a pocket electric flash lamp.

Ascensions were made on only three nights, August 3, 4, and 5, and were begun immediately after sundown. On all other nights the weather was either too windy or too stormy. The balloon was allowed to take as great an altitude as possible and was then kept out until the wind aloft had increased to such an extent that it was necessary to reel in.

Table 11 contains the tabulated data for the three records obtained, and in figures 11 and 12 are plotted the temperature and absolute humidity gradients, re-

spectively; the slight changes with time at the higher levels in each ascension are not plotted; only the ascent and descent proper. On August 3 and 4 these elements diminished with time by nearly the same amounts at all upper levels as at the surface. There was but little wind during these nights. An August 5, however, there was a fairly high northeast wind aloft and the temperature and humidity changed very little with time. The change with altitude in temperature was greater and in absolute humidity less than on the other nights.

TABLE 11.—Results of captive balloon ascensions at Mount Whitney, Cal., Aug. 3-5, 1913.

Date and hour.	Surface.				At different heights above sea.						
	Pres- sure.	Tem- pera- ture.	Rel. hum.	Wind direction.	Height.	Pres- sure.	Tem- pera- ture.	Humidity.		Wind dir.	
								Rel.	Abs.		
Aug. 3, 1913:	Mm.	° C.	%		M.	Mm.	° C.	%	g/cu. m.		
7:13 p. m.	446.2	0.6	80	s.	4,410	446.2	0.6	80	4.0		
7:18 p. m.	446.2	0.3	81	s.	4,533	439.3	-0.2	65	3.1	ese.	
7:25 p. m.	446.2	0.1	80	s.	4,631	434.0	-0.9	65	2.9	ese.	
7:35 p. m.	446.3	0.3	78	calm.	4,689	430.9	-1.5			e.	
7:45 p. m.	446.3	0.2	78	calm.	4,801	424.9	-2.3			e.	
7:58 p. m.	446.3	0.3	75	e.	4,683	431.2	-0.8	26	1.3	e.	
8:06 p. m.	446.3	0.3	73	e.	4,801	424.9	-1.5	18	0.8	e.	
8:10 p. m.	446.3	0.3	74	e.	4,744	427.9	-1.3	16	0.7	e.	
8:15 p. m.	446.4	0.2	75	e.	4,802	424.9	-2.3	13	0.5	e.	
8:18 p. m.	446.4	0.2	76	e.	4,664	432.4	-2.0	26	1.1	e.	
8:31 p. m.	446.4	0.1	78	ene.	4,579	437.0	-1.5	67	2.9	ene.	
8:41 p. m.	446.4	0.0	79	ene.	4,509	440.9	-0.7	68	3.1	ene.	
8:51 p. m.	446.5	-0.2	85	ene.	4,410	446.5	-0.2	85	4.0	ene.	
Aug. 4, 1913:											
6:45 p. m.	446.1	2.3	77	calm.	4,410	446.1	2.3	77	4.4	calm.	
6:49 p. m.	446.2	2.2	78	calm.	4,627	434.3	1.4			calm.	
6:56 p. m.	446.2	2.0	76	calm.	4,852	422.3	-0.9	64	2.9	calm.	
7:04 p. m.	446.2	1.8	74	calm.	5,104	409.1	-2.2	37	1.5	calm.	
7:12 p. m.	446.2	1.6	72	calm.	5,359	396.1	-4.8	34	1.1	ssw.	
7:22 p. m.	446.2	1.6	71	calm.	5,230	402.6	-4.4	33	1.1	s.	
7:45 p. m.	446.3	1.6	70	calm.	5,316	398.3	-5.6	24	0.7	wsu.	
7:56 p. m.	446.3	1.3	67	calm.	5,216	403.3	-4.9	23	0.8	wsu.	
8:25 p. m.	446.3	1.1	60	e.	5,258	401.2	-4.4	19	0.6	sw.	
8:55 p. m.	446.2	1.1	55	calm.	5,201	404.0	-3.6	12	0.4	ssw.	
9:13 p. m.	446.2	1.1	50	calm.	5,229	402.6	-3.6	12	0.4	ssw.	
9:39 p. m.	446.2	0.9	46	calm.	5,299	399.0	-5.6	12	0.4	s.	
10:00 p. m.	446.2	0.8	45	calm.	5,198	404.0	-4.3	12	0.4	s.	
11:45 p. m.	446.0	0.6	51	e.	4,634	433.6	-1.9	10	0.4	e.	
11:50 p. m.	446.0	0.6	51	e.	4,509	440.5	-0.7	23	1.1	e.	
12:00 mdt.	446.0	0.6	51	e.	4,410	446.0	0.6	51	2.6	e.	
Aug. 5, 1913:											
6:38 p. m.	446.0	2.8	51	calm.	4,410	446.0	2.8	51	3.0	calm.	
6:54 p. m.	446.1	2.5	52	calm.	4,625	434.3	0.8	54	2.8	sw.	
7:30 p. m.	446.2	1.8	50	calm.	4,810	424.4	-1.4	54	2.3	ne.	
7:37 p. m.	446.3	1.8	45	calm.	4,995	414.7	-2.5	54	2.1	ne.	
7:52 p. m.	446.4	1.9	47	calm.	4,997	414.7	-3.5	54	2.0	ne.	
8:05 p. m.	446.4	1.8	53	calm.	4,898	419.9	-2.7	54	2.1	ne.	
8:17 p. m.	446.5	1.7	57	calm.	4,999	414.7	-3.4	54	2.0	ne.	
8:42 p. m.	446.6	1.3	55	calm.	4,861	422.1	-1.8	54	2.3	ne.	
8:56 p. m.	446.7	1.2	55	calm.	4,736	428.9	-0.3	53	2.5	ne.	
9:05 p. m.	446.7	1.3	55	ne.	4,820	424.4	-1.1	53	2.4	ne.	
9:30 p. m.	446.6	1.3	51	ne.	4,734	428.9	-0.3	51	2.4	ne.	
9:44 p. m.	446.5	1.2	46	ne.	4,604	435.8	1.0	48	2.5	ne.	
11:00 p. m.	446.1	1.1	38	ne.	4,410	446.1	1.1	38	2.0	ne.	

Aug. 3, 1913.—One captive balloon was used; capacity, 28.6 cu. m. Few Cu., from the east, prevailed throughout the ascension.

Aug. 4, 1913.—One captive balloon was used; capacity, 28.6 cu. m.; lifting force at beginning of ascension, 5.4 kg.

Few Cu., from the south, at 7 p. m. Cloudless by 9 p. m. Lightning was seen over or near Death Valley. There was considerable electricity on the wire.

Aug. 5, 1913.—One captive balloon was used; capacity, 28.6 cu. m. Few Cu., direction unknown, in early evening. Cloudless after 8.50 p. m. Lightning was seen on the eastern horizon, near Death Valley.

TABLE 12.—Temperature differences at 100-meter intervals above Mount Whitney, Cal., Aug. 3, 4, 5, 1913.

Observations.	Altitudes (meters).								
	100	200	300	400	500	600	700	800	900
Aug. 3, 1913:									
Ascent.....	0.6	0.8	0.9	0.6					
Descent.....	0.5	1.0	0.4	0.2					
Aug. 4, 1913:									
Ascent.....	0.4	0.4	0.9	1.0	0.7	0.5	0.6	1.0	1.0
Descent.....	1.3	1.0	0.5	0.4	0.5	0.4	0.4	0.4	0.4
Aug. 5, 1913:									
Ascent.....	0.9	1.0	1.1	1.2	0.8	0.8			
Descent.....	0.1	0.1	0.9	1.2	1.1	1.2			
Means.....	0.63	0.72	0.77	0.77	0.78	0.72	0.50	0.70	0.70

Table 12 contains the temperature differences at 100-meter intervals above the surface, as observed in all three ascensions. The mean gradient is 0.70 and is fairly constant at all altitudes up to 900 meters.

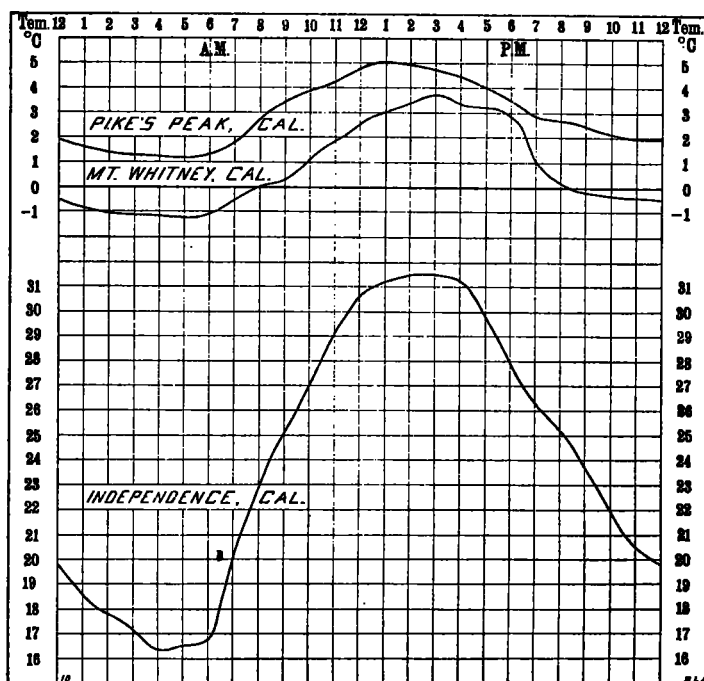


FIG. 10.—Mean hourly temperatures at Mount Whitney and Independence, Cal., August 3 to 12, incl., 1913, and at Pikes Peak, Cal., August 3 to 12, incl., 1893 and 1894.

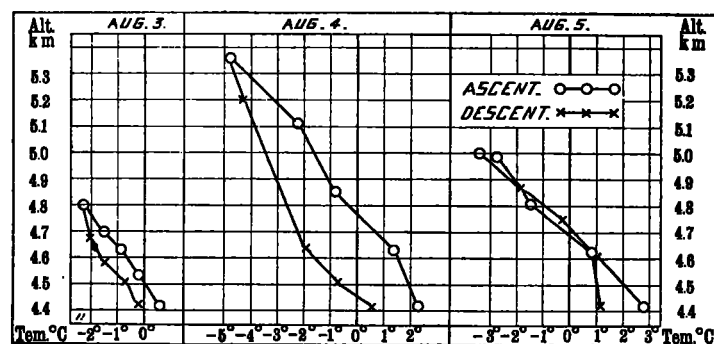


FIG. 11.—Temperature gradients (°C.), above Mount Whitney, Cal., August 3, 4, and 5, 1913.

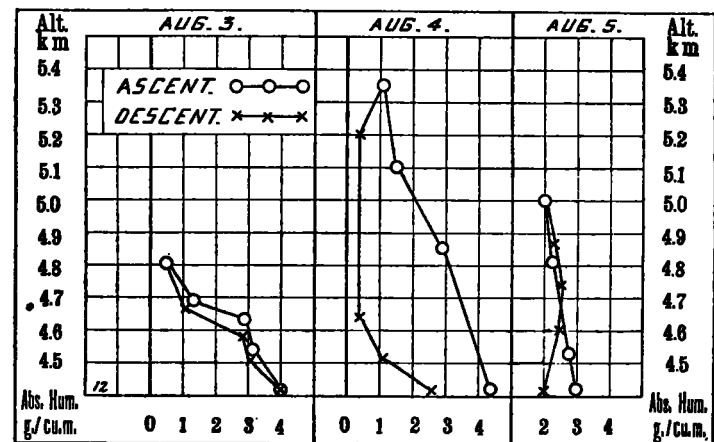


FIG. 12.—Absolute humidity gradients, grams per cubic meter, above Mount Whitney, Cal., August 3, 4, and 5, 1913.

FREE-AIR OBSERVATIONS AT LONE PINE, CAL.

The balloon ascensions were carried out by Mr. P. R. Hathaway from a place about 1 kilometer north of Lone Pine. The instrumental and other equipment was similar to that used at Mount Whitney. Owing to leakage of a large number of gas tubes, only four ascensions were possible. These were made on August 1, 2, 3, and 4 and were begun shortly after sundown. Surface conditions for making ascensions at this time of day were usually excellent.

The records obtained in the balloon ascensions are given in tabular form in Table 13. Figures 13 and 14 show the temperature and absolute humidity gradients, respectively. There was always a marked inversion of temperature between the surface and 200 meters above it, amounting on the average to 6° C. (See Table 14.) From 200 to 300 meters there was practically no change, but above 300 meters the temperature decreased with altitude at a fairly uniform rate, the mean difference per 100 meters being 0.73. On August 2 there was about equal cooling with time at all levels; on the 4th the tem-

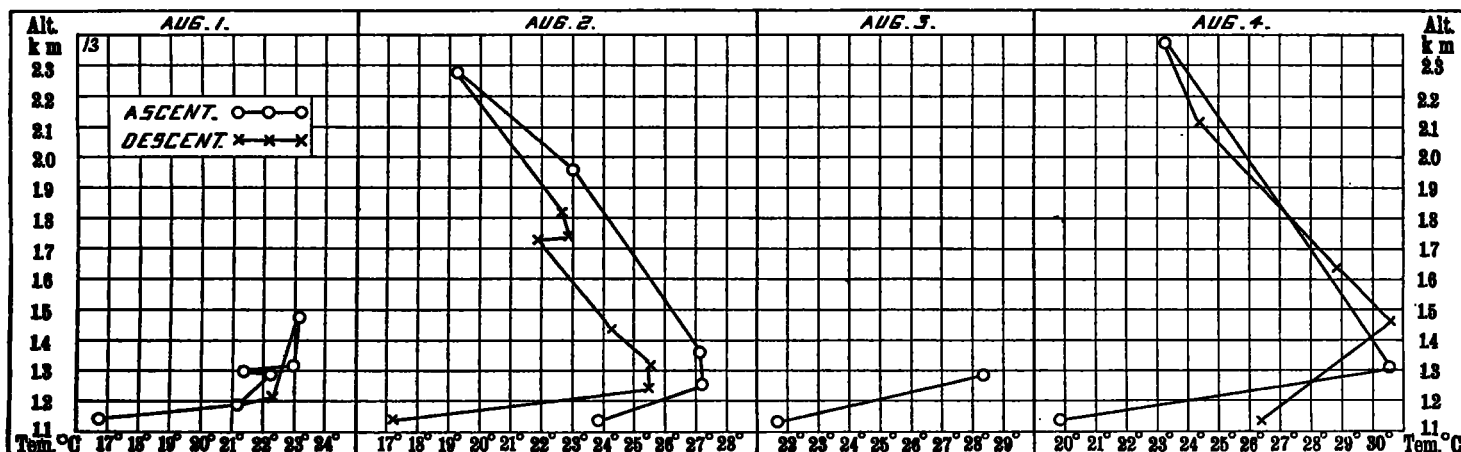


FIG. 13.—Temperature gradients (°C.), above Lone Pine, Cal., August 1, 2, 3, and 4, 1913.

TABLE 13.—Results of captive balloon observations at Lone Pine, Cal., Aug. 1-4, 1913.

Date and hour.	Surface.				At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind direction.	Height.	Pressure.	Temperature.	Humidity.	Wind dir.	
	Mm.	°C.	%		M.	Mm.	°C.	% g/cu. m.		
Aug. 1, 1913:										
9:18 p. m.	660.3	16.7	79	calm.	1,137	660.3	16.7	79	11.1	calm.
9:30 p. m.	660.4	16.7	79	calm.	1,190	656.3	21.1	50	9.1	w.
9:37 p. m.	660.5	16.8	78	calm.	1,296	648.5	22.2	37	7.2	w.
9:44 p. m.	660.6	17.2	77	calm.	1,297	648.5	21.4	37	6.9	w.
10:10 p. m.	660.8	18.3	72	w.	1,311	647.7	23.0	28	5.7	w.
10:15 p. m.	660.8	16.7	80	calm.	1,470	636.0	23.1	24	4.9	w.
10:43 p. m.	661.0	16.7	78	s.	1,204	655.8	22.3	46	9.0	s.
10:48 p. m.	661.1	16.7	78	s.	1,137	661.1	16.7	78	11.0	s.
Aug. 2, 1913:										
7:38 p. m.	658.3	23.9	46	nnw.	1,137	658.3	23.9	46	9.9	nnw.
7:41 p. m.	658.5	24.2	45	nnw.	1,253	649.9	27.2	30	7.7	n.
7:47 p. m.	658.8	22.6	48	nnw.	1,355	642.8	27.1	17	4.4	n.
8:01 p. m.	659.3	19.4	64	s.	1,958	600.4	23.0	17	3.5	calm.
8:48 p. m.	660.0	19.7	57	calm.	2,273	579.8	19.2	23	3.8	se.
9:30 p. m.	660.9	18.6	66	calm.	1,811	612.1	22.7	20	4.0	se.
10:45 p. m.	662.6	17.5	69	s.	1,734	618.9	22.9	20	4.0	sw.
10:56 p. m.	662.8	18.0	64	s.	1,728	619.7	21.9	21	4.0	sw.
11:05 p. m.	662.9	16.4	77	s.	1,432	641.0	24.3	23	5.0	se.
11:13 p. m.	662.9	16.7	75	s.	1,316	649.4	25.0	21	5.0	e.
11:19 p. m.	662.9	17.0	70	w.	1,234	655.5	25.5	21	4.9	e.
11:25 p. m.	662.9	17.2	70	w.	1,137	662.9	17.2	70	10.2	w.
Aug. 3, 1913:										
7:17 p. m.	661.8	21.7	54	calm.	1,137	661.8	21.7	54	10.2	calm.
7:21 p. m.	661.9	21.7	54	calm.	1,296	650.0	28.4	26	7.2	sse.
9:25 p. m.	664.5	22.9	37	sew.	1,137	664.5	22.9	37	7.5	ssw.
Aug. 4, 1913:										
7:19 p. m.	656.9	19.9	58	calm.	1,137	656.9	19.9	58	9.9	calm.
7:22 p. m.	657.0	19.8	57	calm.	1,309	644.4	30.6	.....	.....	se.
7:34 p. m.	657.4	21.0	43	calm.	2,367	572.2	23.2	.....	.....	se.
7:56 p. m.	658.2	22.2	39	s.	2,106	589.9	24.4	.....	.....	sse.
8:02 p. m.	658.3	22.7	38	s.	1,629	622.7	28.9	.....	.....	sse.
8:05 p. m.	658.3	23.0	38	s.	1,459	634.9	30.6	.....	.....	sse.
8:55 p. m.	658.2	26.4	27	s.	1,137	658.2	26.4	27	6.7	s.

Aug. 1, 1913.—One captive balloon was used; capacity, 28.6 cu. m. Cu. Nb., from the west, decreased from 5/10 to a few. Light rain fell for about two minutes at 9.35 p. m.

Aug. 2, 1913.—One captive balloon was used; capacity, 31.1 cu. m. St. Cu., from the south, decreased from 6/10 to a few.

Aug. 3, 1913.—One captive balloon was used; capacity, 31.1 cu. m. 1/10 Cu., direction unknown, disappeared before the end of the ascension.

Aug. 4, 1913.—One captive balloon was used; capacity, 31.1 cu. m. The sky was cloudless.

perature changed but little at upper levels and increased somewhat at the surface.

The absolute humidity (fig. 14) diminished rapidly from the surface to the altitude at which the highest temperature was recorded. Above this, on August 2, the only night in which a record of humidity at higher levels was obtained, it diminished slowly.

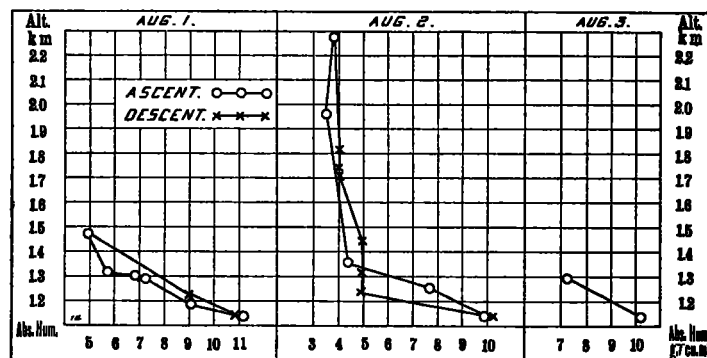


FIG. 14.—Absolute humidity gradients, grams per cubic meter, above Lone Pine, Cal., August 1, 2, and 3, 1913.

TABLE 14.—Temperature differences at 100-meter intervals above Lone Pine, Cal., Aug. 1-4, 1913.

Observations.	Altitude (meters).											
	100	200	300	400	500	600	700	800	900	1,000	1,100	1,200
Aug. 1, 1913:												
Ascent.....	-4.8	-1.5	-0.1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Descent.....	-5.7	-0.3	-0.3	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aug. 2, 1913:												
Ascent.....	-2.7	-0.5	.05	0.7	0.7	0.7	0.7	0.6	1.1	1.2	1.2	.....
Descent.....	-8.3	0.1	1.1	0.8	0.8	-0.2	0.4	0.7	0.8	0.7	0.8	.....
Aug. 3, 1913:												
Ascent.....	-4.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aug. 4, 1913:												
Ascent.....	-6.2	-4.3	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.7
Descent.....	-1.3	-1.3	-1.3	0.5	1.0	0.9	1.0	0.9	0.9	0.8	0.5	0.5
Means.....	-4.74	-1.30	0.10	0.68	0.80	0.52	0.68	0.72	0.88	0.85	0.80	0.60

During the day there was a moderate breeze from the north blowing down the valley. This became very light toward evening, and at about the same time the temperature began to fluctuate, sudden changes of 2° to 5° C. occurring frequently between 6 p. m. and the time of minimum temperature. These fluctuations are well shown in the thermograph records at Independence, Cal. (fig. 15), and in Table 15, which contains observed temperatures and humidities at Lone Pine, Cal. These observations have been referred to by Dr. Wm. R. Blair in his discussion of mountain and valley temperatures (Bull., Mt. Weather obs'y, Washington, 1914, 6: 122) and are in accord with the conclusion there reached that "there is not a stream of cool air past the slope station, but a direct convective interchange between the cool air on the slope and the free air over the valley at the same or slightly lower levels." In general, as shown in Table 15, the lower temperatures were accompanied by the higher absolute humidities.

southerly current aloft, at the same time causes the surface northerly current down the valley.

THE HORIZONTAL RAINBOW.¹

By S. FUJIWARA.

[Dated Central Meteorological Observatory, Tokyo, January 12, 1914.]

The so-called horizontal rainbow has been reported by several scientists. Julius von Hann observed this mysterious optical phenomenon on Lake Constance, and W. R. N. Church has seen it on Loch Lomond. F. Hashimoto observed such a rainbow (or horizontal spectrum) on Lake Suwa in central Japan on the morning of November 3, 1912. On this morning the weather was very clear. He and Count A. Tanaka were then engaged in limnological observation at the shore near Kakuyūkan. Mr. Hashimoto saw the rainbow on the water surface of the northeastern part of the lake. They at first observed the bow with their eyes at a height of 9 feet

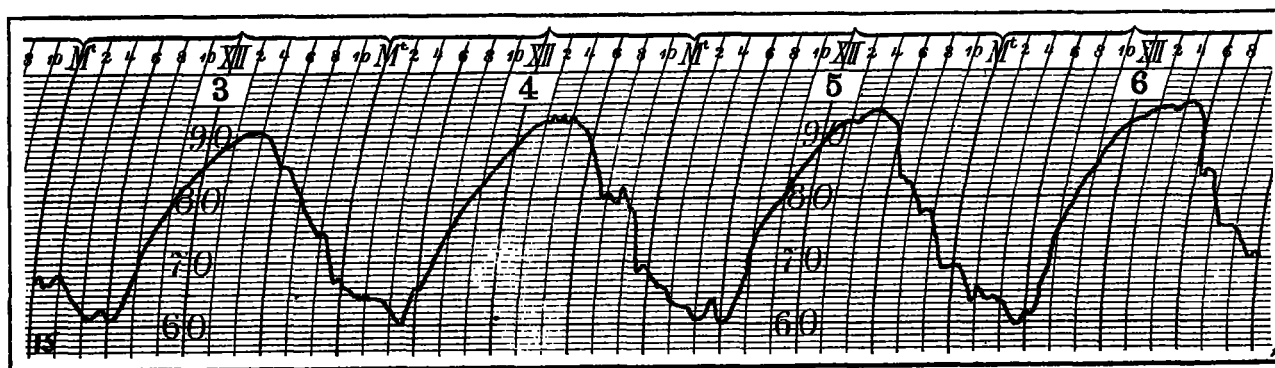


FIG. 15.—Thermograph record ($^{\circ}$ F.), at Independence, Cal., August 3-6, incl., 1913, showing fluctuations in temperature during nighttime.

TABLE 15.—Fluctuations in surface temperature and humidity at Lone Pine, Cal., Aug. 2 and 3, 1913.

Date.	Time.	Temperature.	Relative humidity.	Absolute humidity.
		$^{\circ}$ C.	Per cent.	g/cu. m.
Aug. 2..... 1913.	P. m.			
	7:48	22.2	43	9.3
	7:51	20.6	56	9.9
	8:01	19.4	64	10.6
	8:45	20.0	56	9.6
	9:10	18.7	76	10.6
	9:21	18.7	64	10.2
	10:01	18.7	76	10.6
	11:00	18.3	62	9.6
	11:05	16.4	77	10.7
	11:48	18.9	60	9.6
Aug. 3.....	6:50	25.1	40	9.2
	7:40	21.1	58	10.2
	7:50	19.4	58	9.3
	8:05	20.8	45	8.1
	8:37	19.4	58	8.6
	9:09	21.1	42	7.7
	9:33	23.9	34	7.3
	9:43	21.8	47	8.9

Between 8 and 10:30 p. m. it was necessary to bring the balloon down because of southerly or southeasterly winds aloft. These winds gradually extended toward the surface and were warm and dry (Table 13). The mixing of the upper southerly and the lower northerly currents seems to account for the variations in surface temperature and humidity already referred to.

The fact that the upper southerly wind is warm and dry suggests the probability that it originates over the Mohave Desert, which is about 150 kilometers south of Lone Pine. The heating and consequent rising of air over the desert in the daytime, which gives rise to the

above the water level. On bringing their eyes down to the height of 6 feet the length of the bow diminished, but the colors became very distinct. By lowering their eyes the bow became clearer, and at last, at a height of a little lower than 4 feet, it vanished. At any height lower than this they could no more see the bow, but above this height the bow was seen. As the sun rose higher the bow shifted to the right and vanished from them at 11 a. m., while standing on the shore; soon they went up the stairs of an inn near by, and thence they could perceive the bow, though indistinctly. The position of the lake and features of the bow on this occasion were as shown in figure 1. About 8 a. m. on December 8, 1913, Mr. Hashimoto again observed a similar phenomenon on the same lake. At this time he was in a boat making limnological observations. In his letter to me he states the results of his observations. On the morning in question the surface temperature of the water of the lake was 8° C. and that of the air was about 3° C. He also observed a very thin haze or mist over the surface of the lake and the air was very calm. The optical conditions on December 8, 1913, are presented in figure 2, where the plane of the figure represents the surface of the lake water; OS' is the horizontal projection of the sun's ray passing through O, the position of the observer, Mr. Hashimoto. OV and OR are the limiting rays of the horizontal rainbow RV. The angle ROV has been estimated at about 3° , and the horizontal angle VOS at 38° . The violet side of the bow is indicated by OV and the red side by OR.

¹ Revised and reprinted from Jour. met. soc. Japan, Tokyo, March, 1914.